PROGRESS REPORT 2008

May 2009

Progress Report to IIASA's National Member Organizations and Governing Council on IIASA's Research and Other Activities in 2008

International Institute for Applied Systems Analysis
Schlossplatz 1, A-2361 Laxenburg, Austria
Tel: +43 2236 807 Fax: +43 2236 71313
www.iiasa.ac.at

Registration number: ZVR 524808900

Contents

Introduction

This is the third Progress Report for the **IIASA Research Plan 2006-2010** and presents the scientific work carried out at the Institute during 2008. It updates the Council and National Member Organizations of IIASA about the scientific achievements and policy impact of the Institute's Research Program during the last year, and outlines their activities for 2009.

That 2008 was a year of change is perhaps an understatement to those who are familiar with IIASA and its work. On 1 June 2008 IIASA's eighth director, Leen Hordijk, took up a new post in Italy after six years "on board." The rudder was placed in the capable hands of Acting Director, Sten Nilsson, and Acting Deputy Director, Nebojsa Nakicenovic, for the rest of 2008. Then IIASA's new Director, Detlof von Winterfeldt, took office on 1 January 2009 with Nebojsa Nakicenovic continuing as Deputy Director. At the same time, Peter Lemke took over as Chairman of the IIASA Council from Simon Levin, who had held this post for five years. The contributions of Leen Hordijk, Simon Levin, and Sten Nilsson to IIASA have been nothing short of exceptional; I offer them our deepest gratitude and wish them well in their future endeavors.

A great deal of preparation was put into ensuring a seamless transition during what would prove to be a pivotal year for IIASA from both the internal and international standpoints. Indeed, expansion of the Institute's income in 2008 and an increase in the number of person-years worked by scientists are testimony to the informed and inclusive planning conducted by IIASA's Council and Directorate.

These same qualities were visible, too, in the work to develop a new research strategy for IIASA. In this process, the world's most pressing social and environmental issues—together with the capacity of science in general and IIASA in particular to address them—were debated at meetings with staff, national member organizations, and external stakeholders. A formal IIASA Strategic Plan 2011–2020 will be published in late 2009.

As talks about IIASA's future direction progressed, many current projects were bearing fruit. Preparations took place throughout the year for the 14th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in Poznan, Poland, in December, with IIASA hosting or participating in many activities. And particularly pleasing was that IIASA researchers also carried on publishing prolifically with 109 journal articles published—more than ever before.

In 2008 IIASA continued to build its **portfolio of data, model, and research tools,** to assist policymakers confronted with difficult decisions on complex issues.

- The Air Pollution and Economic Development Program developed a **Web-based GHG Mitigation Efforts Calculator,** which allows interactive comparison of mitigation efforts and costs among the Annex 1 Parties to the Kyoto Protocol and their likely effects in 2020. The Calculator may be instrumental in negotiations to elaborate a new Protocol at the 15th Conference of Parties to the United Nations Framework on Climate Change in Copenhagen in December 2009.
- The Land Use Change and Agriculture Program and the United Nations Food and Agriculture Organization released a new state-of-the-art **Harmonized World Soil Database** which will provide information for national and international policymakers seeking to achieve sustainable expansion of agricultural production leading to food security.
- In 2008 the World Population Program published its third update of **probabilistic world population projections for 13 world regions,** with a focus on the expected speed of population aging rather than on population growth as in the past. The results were published in the journal Nature.
- **Representative Concentration Pathways** with full spatial coverage of land-cover changes as well as pollutant emissions and greenhouse gases were developed by the Energy Program. These will provide an invaluable tool to the world's climate modeling teams as they prepare the climate change projections of the IPCC's Fifth Assessment Report.

IIASA continued to be an international meeting place for high-level scientists and policymakers.

- A workshop on the vulnerability of methane hydrates, jointly organized by the Transitions to New Technologies Program and the Global Carbon Project in March, drew together eminent scientists from the energy field. The workshop findings featured in the journal *Science*.
- The French Ambassador to the International Organizations in Vienna, Mr. Francois-Xavier Deniau, hosted ambassadors from the 27 member states of the European Union at IIASA in July for consultations with counterparts at the start of France's European Union Presidency.
- In February the Risk and Vulnerability Program held a workshop on disaster risk in Madagascar, funded by the Provention Consortium and the World Bank. This was part of its program to cooperate with countries in Latin America, Asia, and Africa that are highly exposed to climate-change-related disasters.
- In June 2008 the "Theorists meet Practitioners" workshop, organized by the Processes of International Negotiation Program, was attended by over 50 participants including 10 ambassadors, numerous military officials, NGO representatives, university professors, and students from all over the world.
- In November IIASA welcomed the United Kingdom's Chief Scientific Advisor, Professor John Beddington, who delivered the annual Koopmans Lecture on "Science and Innovation in the 21st Century" to around 200 invited guests from Vienna's scientific and diplomatic community at the Albertina Museum.

These achievements and events have been selected from among many to show the significant reach and influence of

IIASA research during the year, particularly in the policy area. Indeed, the role of the Institute as a policy advisory body was heightened in October 2008, with the agreement by United Nations Secretary-General Ban Ki-moon to accept regular policy briefings from IIASA on systems-oriented approaches to global change issues.

As the new Director of IIASA, I look forward to emulating my predecessors' commendable achievements and to implementing an innovative and exciting new strategy to ensure IIASA's continued success during the next phase in its development.

Detlof von Winterfeldt
Director
May 2009

Part I

Environment and Natural Resources

Atmospheric Pollution and Economic Development Program

Markus Amann
amann@iiasa.ac.at

Objectives

IIASA's Atmospheric Pollution and Economic Development (APD) Program develops innovative modeling tools that identify strategies to protect the local, regional, and global atmosphere while imposing the least burden on economic development. Its research brings together the geophysical and economic aspects of pollution control within one assessment framework. Together with a network of collaborators, APD uses this framework as a basis for conducting practical policy analysis in different regions of the world.

Scientific Achievements and Policy Impacts

In 2008 APD completed the new setup of its Greenhouse Gas–Air Pollution Interactions and Synergies (GAINS) model. The new framework now holds quality-controlled data for the entire world, building on a coherent database structure that integrates data for 18 pollutants, 1,300 types of economic activity, and 238 regions/countries. It is freely accessible on the Internet (http://gains.iiasa.ac.at) through a new interactive user interface. By the end of 2008 more than 900 users had activated their registration with the GAINS model.

Based on this core tool, APD explored a variety of issues that are relevant for atmospheric pollution and economic development in different world regions.

Aerosols

With increasing scientific understanding of the sources and impacts of aerosols in the atmosphere, concerns are growing about their detrimental effects on human health at the local scale, as well as their impacts on climate at the regional and global level. According to recent studies, the reduction in fine particulate air pollution that occurred in 51 U.S. metropolitan areas between the late 1970s and early 2000s is responsible for as much as 15 percent of the overall increase in statistical life expectancy in these areas (five months) (Pope *et al.*, 2009). Analyses using IIASA's GAINS-Asia model suggest that potential changes in particle levels in third-world cities and households are more than an order of magnitude higher than those that occurred in the USA during the period of the U.S. study (Amann *et al.*, 2008).

At the same time, aerosols exert significant radiative forcing that contributes to climate change, especially in the near term and at the regional scale. As sulfate, nitrate, and organic carbon aerosols have a cooling effect, emissions of these short-lived substances mask climate change that is already committed by the presence in the atmosphere of long-lived greenhouse gases emitted in the past. It is therefore argued that a rapid reduction in aerosols in the interests of protecting human health could accelerate near-term climate change at the local scale (Ramanathan, 2008).

The recently completed aerosol emission components of the GAINS model quantify emissions of the important aerosol components (inter alia, black carbon, organic carbon, fine particles (PM2.5 and PM1), sulfur dioxide (SO_2), nitrogen oxide (NO_x), and ammonia (NH_3). On this basis, APD, along with Chinese and Indian collaborators, has produced a new assessment of current and future emissions in Asia (Klimont *et al.*, 2009, in review). This improves the assessment of health impacts in Asia and adds important information to global climate models. GAINS estimates of the potentials for and costs of reducing particulate matter and carbonaceous aerosols are documented in a forthcoming journal article about black carbon abatement strategies (Rypdal *et al.*, 2009). New global emission projections have been submitted to the preparatory process for the April 2009 Ministerial Meeting of the Arctic Monitoring and Assessment Programme (AMAP), which will explore policy options regarding cost-effective measures for slowing the warming of the Arctic.

In the longer run, the new GAINS model offers a tool for exploring critical trade-offs between air pollution abatement and greenhouse gas (GHG) mitigation measures, which will help informed decisions to be made about specific policy actions.

Emission scenarios developed with the global version of the GAINS model provided the quantitative basis for the report of the UK Royal Society on "Ground-level ozone in the 21st century," published in October 2008.

GAINS-Asia

In 2008 APD, together with Chinese, Indian, and Pakistani collaborators, completed the GAINS implementation for Asia. The new tool allows a comprehensive assessment of cost-effective air pollution control strategies in these countries, together with a systematic analysis of their potential co-benefits for greenhouse gas emissions. For alternative assumptions on economic development, GAINS-Asia quantifies emissions and control potentials for six air pollutants and six greenhouse gases; it also quantifies air pollution impacts on human health (from outdoor and indoor exposure) and on vegetation, as well as identifying cost-effective emission control strategies. An interactive user interface enables open access to the full model via the Internet (http://gains.iiasa.ac.at) to enable local experts to conduct their own analyses. Full model documentation, tutorials, policy analysis reports, and a policy briefing brochure have also been made available on the Internet. GAINS-Asia was officially launched at the Better Air Quality (2008) Conference of the Clean Air Initiative Asia in October 2008 in Bangkok (www.baq2008.org).

The GAINS analysis reveals that current economic growth will intensify air quality problems in Asia, unless the existing pollution control laws are significantly upgraded. Loss in human wel-

fare from adverse health impacts of air pollution would offset a significant share of the expected improvement from greater economic wealth. The report points out that (e.g., for China) a targeted approach developed using the GAINS-Asia model can reduce air pollution control costs by up to 80 percent compared to a conventional across-the-board application of advanced emission control technologies. Well-designed air pollution control strategies can reduce costs further and at the same time reduce greenhouse gas emissions (http://gains.iiasa.ac.at/gains/download/gainsbrochure_web.pdf) (see *Figure 1*).

In addition, APD hosted the 11th Workshop of the Model Intercomparison Study for Asia, which brought together atmospheric modelers from China, Japan, and the Republic of Korea to conduct a comparison of modeled transboundary flows of pollution in Asia.

Comparison of Greenhouse Gas Mitigation Efforts of UNFCCC Annex 1 Countries

In 2008 APD used its GAINS model to develop a methodology for the systematic comparison of greenhouse gas mitigation efforts among different countries. This analysis will provide relevant information to the ongoing climate negotiations under the United Nations Framework Convention on Climate Change (UNFCCC) on quantitative post-2012 targets for the industrialized countries. APD, together with IIASA's Forestry (FOR) Programme, has developed a systems approach for comparing mitigation potentials and costs among all economic sectors in different countries. A first version has been implemented for 36 UNFCCC Annex 1 countries (i.e., Australia, Canada, the 27 countries of the European Union (EU), Japan, New Zealand, Norway, Russia, Switzerland, Ukraine, and the USA). An interactive Web tool (http://gains.iiasa.ac.at/MEC) allows comparison of the implications of user-specified international mitigation regimes for individual parties to the UNFCCC in terms of a range of conceivable equity indicators (e.g., per capita emissions, relative emission reductions in relation to a base year, marginal costs, per capita costs, costs per GDP). In addition, the analysis quantifies the co-benefits of greenhouse gas mitigation for the emission of air pollutants.

APD presented the methodology to the climate negotiators and launched the interactive Mitigation Efforts Calculator at an IIASA side event at the 14th Conference of the Parties (COP 14) to the UNFCCC held in Poznan, Poland, in December 2008.

Initial results indicate that future mitigation efforts are strongly dependent on the baseline assumptions about economic development and current energy efficiency performance. If emission reductions are related to a common base year (e.g., 1990), large differences across Annex 1 countries are associated with, inter alia, the recession periods that occurred, for example, in Eastern European countries after 1990. Furthermore, as many mitigation measures are capital-intensive, the cost of capital (i.e., the interest rate) has a decisive impact on total mitigation costs. For instance, a social welfare perspective that considers long-term capital productivity (e.g., 4 percent) would suggest that by 2020 Annex 1 countries could reduce their total emissions by 16 percent below the 1990 levels at zero total cost. In contrast, from a private consumer's perspective (assuming a 20 percent rate of return), only a 4 percent reduction appears at zero cost (*Figure 2*).

Europe

The European implementation of GAINS is now an established tool for policy analyses for the European Commission and the Convention on Long-range Transboundary Air Pollution of the

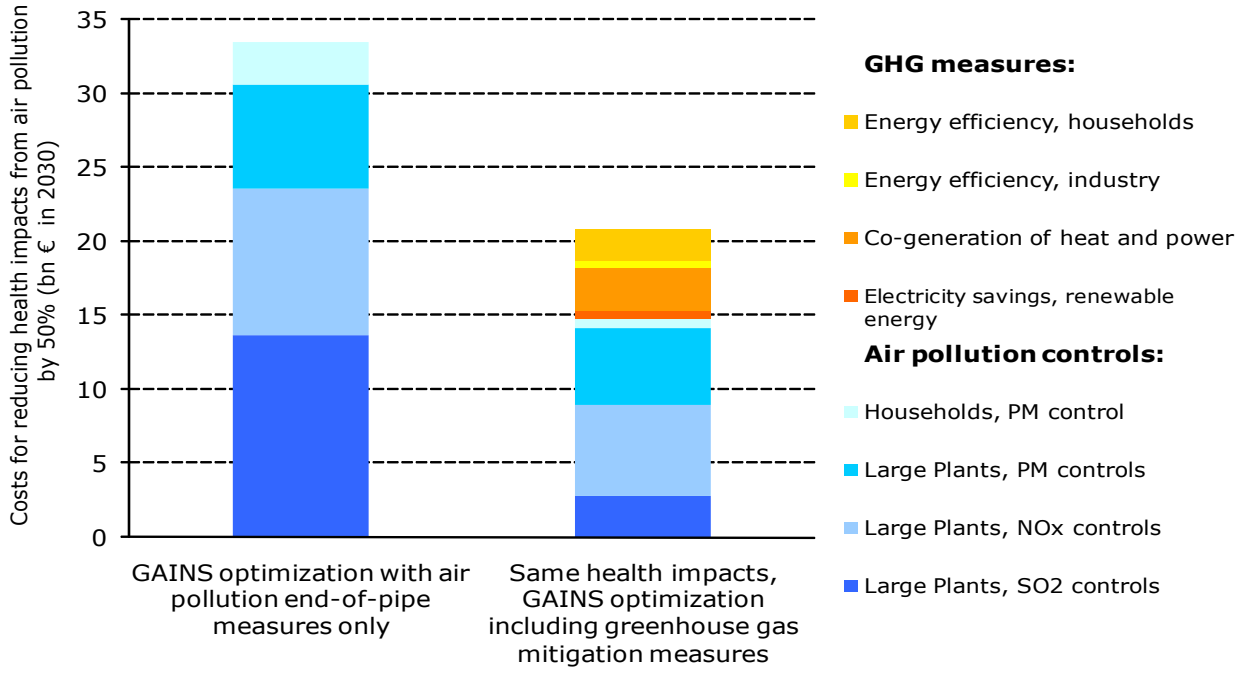


Figure 1. Emission control costs for reducing the health impacts of particulate matter (PM) in China by 50 percent

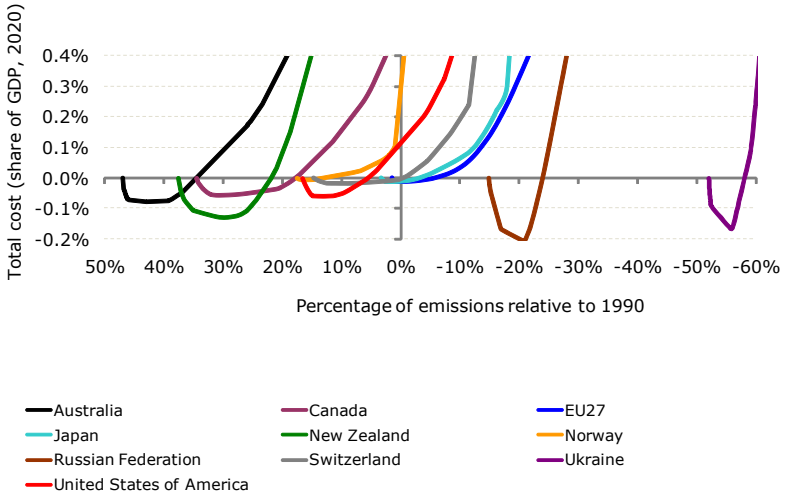


Figure 2. Comparison of GHG mitigation costs in 2020 for Annex 1 countries, excluding the Land Use, Land Use Change, and Forestry (LULUCF) sector, using a 4 percent interest rate.

United Nations Economic Commission for Europe (UNECE). In 2008 work at APD focused mainly on the policy applications of the GAINS tool and the underlying data compiled in earlier years.

In 2008 GAINS analyses provided quantitative information to the European Commission for the proposal and subsequent negotiations on the EU Climate and Energy Package. GAINS estimated national mitigation costs for non-carbon-dioxide (CO_2) emissions and co-benefits that occur as a side effect of greenhouse gas (GHG) mitigation strategies on air pollution in the 27 member states. The policy package, which aims, inter alia, at a 20 percent reduction of EU GHG emissions by 2020 as a unilateral measure, was finally accepted by the European Council in December 2008.

A further line of work related to the revision of the EU National Emission Ceilings Directive, which will specify national caps on the emissions of SO_2, NO_x, PM2.5, NH_3, and volatile organic compounds (VOCs). A policy report explores the cost-effective sets of additional measures that would be required to meet, in 2020, the environmental targets of the Thematic Strategy on Air Pollution and how economic burdens will be distributed across economic sectors and member states. It was found that a large share of the additional efforts originally foreseen to meet the air quality targets will emerge as a side effect of the structural changes implied by the Climate and Energy Package and that costs for additional air pollution control measures will significantly decline (www.iiasa.ac.at/rains/reports/NEC6-final110708.pdf).

In late 2008 the global version of GAINS was used to estimate the co-benefits of global GHG mitigation strategies for air pollution emissions as an input to the forthcoming Communication of the European Commission on the EU negotiation strategy for the post-2012 climate agreement.

A report on the cost-effectiveness of emission controls from marine shipping, produced by APD in 2007 (www.iiasa.ac.at/rains/reports/IR06-107_Ships.pdf), contributed to the 2008 agreement within the International Maritime Organization on reducing the global limit on the sulfur content of fuels from 4.5 percent currently to 0.5 percent, and 0.1 percent in specific Sulphur Emissions Control Areas. In addition, tighter standards for NO_x emissions were agreed.

The Convention on Long-range Transboundary Air Pollution, which has officially designated IIASA as its Centre for Integrated Assessment Modelling, embarked in 2008 on negotiations on the revision of its Gothenburg multi-pollutant/multi-effect Protocol. Negotiations explore, inter alia, ways of increasing the participation of non-EU parties in Central and Eastern Europe, for which the complexity of the obligations laid down in current protocols are emerging as obstacles to implementation. A policy analysis report produced by APD demonstrates that efficient implementation of a handful of measures that are already widely applied in Western Europe could lead to significant and cost-effective improvements of air quality in Eastern Europe (www.iiasa.ac.at/rains/reports/CIAM percent20 report percent201-2008v2.pdf).

Emissions from Biofuel Generation

Co-authorship of a publication by APD scientist, Wilfried Winiwarter, with Nobel laureate Paul Crutzen and two other researchers, created considerable media attention and scientific interest. The paper (Crutzen *et al.*, 2008) demonstrates that nitrous oxide (N_2O) emissions associated with the agricultural production of biofuels may more than compensate, in terms of greenhouse gas emissions, for the reduced fossil fuel CO_2 emissions, when assuming global average conditions rather than idealizations in agriculture. Wilfried Winiwarter received invitations to give six presentations, including one in the Austrian parliament (upon

invitation of the third president of the parliament), radio interviews, and newspaper interviews. Similar commitments were undertaken by each of the other authors. To date, the paper has been cited 50 times according to SCOPUS (together with the non-reviewed "discussion" version also available).

Activities in 2009

In 2009 APD will address trade-offs of aerosol reduction strategies between local health and global climate impacts. The inclusion of calculations of (regional) radiative forcing into GAINS (in cooperation with Norwegian colleagues) is envisaged.

APD will continue to refine its work on the comparison of greenhouse gas mitigation potentials, organize a review meeting, and make the analysis available to the negotiations on the revision of the Kyoto Protocol. APD will continue policy analyses with its GAINS model for Europe and Asia and focus on case studies for developing countries, especially those that have recently joined IIASA. A further line of work will assess the macroeconomic implications of investments in air quality improvements.

Scientific Recognition

Markus Amann

- Member of the Clean Air Commission of the Austrian Academy of Sciences
- Member of the UK Royal Society Working Group on "Ground-level ozone in the 21st century"

Invited lectures:

- Southern Africa Sub-Regional Policy Dialogue on Air Pollution (Lusaka, Zambia, 5–6 March 2008): "Tackling regional air Pollution: The approach of the Convention on Long-range Transboundary Air Pollution. Integrated assessment and links to climate change."
- World Health Organization, Meeting of Senior Advisors to Governments on "Climate and Health" (Bonn, 8 March 2008): "Reducing greenhouse gases: Co-benefits on health through lower air pollution."
- United Nations University (UN Headquarters, New York, 23 April 2008): "Air pollution and industrialization."
- Joint Workshop of the United Nations Economic Commission for Europe (UNECE) Task Force on Hemispheric Transport of Pollutants and the US National Academy of Sciencies (Washington DC, USA, 9–12 June, 2008): "Future scenarios of anthropogenic emissions."
- European Parliament, Symposium on "The Integration of Climate Change and Air Pollution Strategies" (Strasbourg, 6 November 2008): "Co-benefits of GHG mitigation strategies on air pollution in Europe."
- Clean Air Initiative Asia, Better Air Quality 2008 Conference (Bangkok, 12 November 2008): "GAINS-ASIA—A tool to combat air pollution and climate change simultaneously."

Janusz Cofala

Invited lectures:

- Peking University, International Workshop on Mega-city and Regional Air Pollution (Guangzhou, 18–20 January 2008). "Integrated assessment of air pollution and greenhouse gases mitigation: Applications for Europe and preliminary results for China."
- Conference on "Air Pollution from Ships" (Lisbon, 20 November 2008) Keynote presentation: "Health and ecosystems impacts of air pollution in Europe today and tomorrow: Role of shipping sector."

Pallav Purohit

- Member of the Editorial Board, *Sustainability Journal*, published by MDPI, Switzerland
- Member of the Editorial Board, *The Open Renewable Energy Journal*, published by Bentham Science Publishers Ltd.

Fabian Wagner:

Invited lectures:

- Swedish Meteorological and Hydrological Institute (Norrkoepping, Sweden, 29–30 September 2008): "Integrated Assessment Modelling with the RAINS model."

Wilfried Winiwarter:

Invited lectures:

- International Energy Agency, Workshop on Bioenergy (Salzburg, 5 February 2008): "N_2O emissions from fertilizer use."
- Austrian Academy of Sciences, Clean Air Commission (Vienna, 11 March 2008): "Balancing emissions of biofuels: The role of N_2O."
- Austrian Parliament, Enquete: "Bio-fuels: Threats or Blessings?" (Vienna, 18 April 2008): "A new perspective on N_2O emissions."

Annex

Internal Collaboration and External Contracts

Internal collaboration

Macroeconomic impacts of investments and health effects of clean air policies

Cooperation with Warren Sanderson of the World Population Program (POP) to identify using the SEDIM model macroeconomic impacts of investments into clean air through (a) setting aside capital for non-productive purposes, (b) improved life expectancy of people, influencing saving behavior and retirement age, and (c) higher labor productivity due to less illness. Erich Striessnig (formerly of POP) has been hired by APD to continue working on this aspect with Warren Sanderson using SEDIM.

Integrated nitrogen management in China: INMIC

An activity of the Greenhouse Gas Initiative (GGI) undertaken by the Land Use Change (LUC) Program and APD.

Growing population and increasing standards of food quality in China have led to an expansion of agricultural production. In the Integrated Nitrogen Management in China (INMIC) project, the consequences of this expansion for the environment were investigated, specifically the release of nitrogen compounds. A framework of indicators was developed, quantifying environmental impacts as a function of the drivers and potential abatement measures. The framework combines elements from demand-driven agricultural modeling (LUC-CATSEI model) and simulations of the fluxes to air and water (GAINS model and MITERRA model, respectively). In the overall framework, the drivers and trends of agricultural intensification were used to compile indicators of nitrate leaching and the release of nitrous oxide and ammonia into the environment in China. This allows assessment of the magnitude of environmental loads under alternative demographic and socioeconomic scenarios, providing policy suggestions on alternative pathways to mitigating or minimizing negative environmental and health risks from agriculture.

LULUCF mitigation potentials for Annex 1 countries

See above under GAINS-Annex 1, the Forestry Program estimates of mitigation potentials and costs for the land use, land use change, and forestry (LULUCF) sector

Impacts of urbanization trends on future health impacts of air pollution

A paper was published on how total health impacts of air pollution in China are expected to change (a) because of changes in emissions and (b) because of changes in urban population from migration (co-authors: Wolfgang Schöpp, APD, and Cao Gui-Ying, FOR). A paper entitled "Sensitivity study on the impact of urbanization on the GAINS methodology to calculate health impacts from air pollution" was presented at the IIASA–Peking University Symposium on Urbanization and Environment in China, 22–23 November 2008.

Human Development Index

APD participated with the Population and Climate Change Project (PCC), ENE, and Landis McKellar of the Health and Global Change (HGC) project in the GGI project on the effectiveness of alternative investments to improve the Human Development Index. The calculation of health benefits from investments in air pollution control are ongoing

Software environment for GAINS

APD cooperated with Marek Makowski of the Integrated Modeling Environment (IME) Program to implement the GAINS optimization into a new software package released by the Risk and Vulnerability (RAV) Program.

Air pollution emissions of global long-term scenarios

There was cooperation by APD with the Energy (ENE) Program to calculate air pollution emissions using the MESSAGE long-term scenarios. APD contributed to the Royal Society report on ground-level ozone, and to the scenarios on Representative Concentration Pathways (RCPs) of the Intergovernmental Panel on Climate Change (IPCC).

External Contracts

Title	*Funder, amount to IIASA*	*Scope*	*Rationale for using IIASA*
EC4MACS	EU, DG-ENV LIFE programme 2006–2012 €2,469,694 (for APD)	APD serves as coordinator of the "European Consortium for Modelling Air Pollution and Climate Strategies," established by DG-ENV to provide institutional long-term funding for integrated assessment modeling with GAINS (includes, inter alia, a work element with FOR)	Maintain GAINS operational and accepted for EU policy analysis, coordinate network of collaborators to contribute required data
CityZen	EU, DG-RTD 2008–2011 € 133,334	Improve modeling of urban air pollution in mega-cities and climate impacts, provide socioeconomic input from GAINS to scientific project	Improve GAINS data for megacities
ClimateCosts	EU, DG-RTD 2008–2011 €81,836 (for APD)	Contribute GAINS co-benefit assessment of GHG mitigation to a comprehensive assessment of the full costs of climate change	Increase visibility of GAINS through contribution to a high-visibility study
ACCENT	EU, DG-RTD, 2004–2009 €487,502	ACCENT=Network of Excellence on Atmospheric Composition Change, involves 43 institutes; APD is leading one of the four sub-projects of ACCENT on "Atmospheric Composition Change"	Maintain and increase IIASA's reputation in this area
EUCAARI	EU, DG-RTD 2007–2010 €184,600	EU project on aerosol modeling	Connect GAINS activities to state-of-the-art modeling on aerosols
EU DG-ENV Framework contracts	DG-ENV	Framework contract for ad hoc policy studies with GAINS; recent studies include work on National Emission Ceilings (GAINS as main tool), the EU Climate and Energy Package, the control of international ship emissions (leading to the MARPOL agreement on limits of SO_2 and NO_x emissions), etc.	Apply GAINS for actual policy analyses
CIAM	UNECE Convention on Long-range Transboundary Air Pollution (Geneva) open-ended, ~€150.000 annually	IIASA has been assigned as the "Centre for Integrated Assessment Modelling" of the European Monitoring and Evaluation Programme (EMEP) of the Convention. This implies annual funding from the mandatory contributions that parties make to EMEP. IIASA carries out modeling for the negotiations of the various Protocols, and acts as a coordination center for national contributions in this field.	GAINS emerged as the central tool for the integrated assessment activities of the Convention
GAINS-Italy	ENEA (National Agency for New Technologies, Energy and the Environment) 2009–2010	Italy uses a national (zoom-in) version of GAINS for national policy analyses. IIASA is developing the required software features and hosts the databases on its Web server.	Support to national experts using GAINS
GAINS-NL	PBL (National Institute for Environment) 2009 €50,209	The Netherlands uses a national (zoom-in) version of GAINS for national policy analyses. IIASA is developing the required software features and hosts the databases on its Web server.	Support to national experts using GAINS

Title	*Funder, amount to IIASA*	*Scope*	*Rationale for using IIASA*
GAINS-Ireland	Irish EPA 2009 ~ €50,000	Ireland uses a national (zoom-in) version of GAINS for national policy analyses. IIASA is developing the required software features and hosts the databases on its Web server.	Support to national experts using GAINS
GAINS-Russia	Swedish Environmental Research Institute 2009	Sweden is financing a project in Russia and Ukraine to motivate national experts in these countries to implement GAINS for their own analyses. The aim is to reengage these countries in the international negotiations in Geneva. IIASA does the training and will host databases on its Web server.	Support to the international community to strengthen involvement of Eastern European countries in international negotiations
Arctic warming	Arctic Council, AMAP (Arctic Monitoring & Assessment Programme) tbd.	Contribute GAINS cost-effectiveness analysis for carbonaceous aerosols to the ministerial meeting on delaying Arctic warming	Support international policy process on the Arctic
GAINS-Asia	EU, DG-RTD 2005–2009 €348,002	Implementation of GAINS for China and India, to increase local awareness of the importance of the interactions between air pollution control and GHG mitigation in developing countries. IIASA was responsible, inter alia, for coordination and involvement of key institutions in China (Energy Research Institute, Tsinghua University) and the Energy Resources Institute (TERI) in India. Receives favorable support from national member organizations (NMOs) in these countries.	(i) Develop GAINS as a policy analysis tool for developing countries,; (ii) Promote IIASA's reputation in the analysis of co-benefits; (iii) Strengthen cooperation with national teams of NMO countries, offer practical tools to NMOs.
MICS-Asia	EANET annually ~€20,000	Host annual workshops on inter-comparison of atmospheric long-range dispersion models for Asia, paid for by the East Asian Network for Acid Deposition, an international network, based at the United Nations Environment Program (UNEP) Bangkok, financed by Japan.	(i) Establish IIASA as a neutral place for Chinese, Japanese and Korean scientists to discuss historically contentious issues; (ii) Keep a foot in the door when Asian countries embark on policy negotiations/calculations.
Toyota Ozone Project	Toyota 2009 €35,698	Explore future threats of increasing ground-level ozone in Asia on human health and ecosystems; provide scientific assistance to Tsinghua University and TERI.	Continue cooperation with TERI and Tsinghua; keep contacts with Toyota
GAINS-Pakistan	IIASA core funds	Implement GAINS for Pakistan (mainly via YSSP involvement)	For the Pakistan NMO
Korean NMO	IIASA core funds	Establish scientific cooperation with Korean institutions	For the Korean NMO
UK Royal Society	IIASA core funds	Contribute to the recent ozone report of the Royal Society	Visibility of IIASA in UK
WHO Global Burden of Disease	IIASA core funds	Contribute to the forthcoming reassessment of the Global Burden of Disease of the World Health Organization	Maintain contacts and credibility with health community, increase visibility of IIASA

Evolution and Ecology Program

Ulf Dieckmann
dieckman@iiasa.ac.at

Introduction

IIASA's Evolution and Ecology Program analyzes and forecasts how evolutionary dynamics shape ecological populations and communities. Specific challenges addressed range from assessing and managing human-induced evolutionary changes in exploited fish stocks, to fostering cooperation in groups of unrelated agents, and to understanding and forecasting the impact of environmental disturbances on the structure and functioning of food webs. Together with its network of international collaborators, the Program is driving the development and application of adaptive dynamics theory, a framework recognized by many as the most versatile tool currently available for linking the ecological and evolutionary consequences of environmental change. Based on a two-pronged attack through applied and methodological research, the Program establishes bridges between fundamental and policy-oriented, theoretical and empirical, biological and mathematical, and analytical and numerical approaches to the systems analysis of ecological and evolutionary change.

The sections below briefly review EEP's research accomplishments in 2008, structured according to the Program's four main research projects, as established in EEP's research plan for 2006–2010.

Adaptive Dynamics Theory

A backbone of EEP's research activities, adaptive dynamics theory provides versatile tools for analyzing the complex interplay between population ecology, phenotypic evolution, and environmental change. The EEP Program continues to develop the adaptive dynamics toolbox at the leading edge of international research through a concerted line of mathematical and applied projects.

To integrate the evolutionary analysis of evolutionary models, adaptive dynamics theory emphasizes their common properties and offers overarching tools. A first overview of the theory of adaptive dynamics and of the use of bifurcation tools in it is presented in a new textbook, published by Princeton University Press. A second book (Dieckmann and Metz, in preparation) is forthcoming and will describe the methods and applications of adaptive dynamics theory in a series of pertinent reviews.

As an important contribution to model integration, it was proved that when continuous strategies are sufficiently similar, almost all ecological models are evolutionarily equivalent to so-called Lotka-Volterra models (Durinx *et al.*, 2008). The great advantage of the latter models, and hence the significance of this equivalence, is that they enable relatively easy calculations of evolutionary predictions. In addition to work on the definition and determination of fitness measures (Metz, 2008, submitted; Parvinen and Metz, 2008), it was also shown under what conditions evolutionary predictions are simplified through the existence of optimization principles, both in clonally reproducing populations and in sexual populations with diploid Mendelian genetics (Metz *et al.*, 2008a, 2008b).

Among all behavior in ecology, foraging behavior stands out for its critical population dynamical implications. An overarching analysis dealt with the evolution of foraging behavior on heterogeneous resources (Heino *et al.*, 2008c). Likewise, body size is by far the most important determinant of a species' population dynamics. Applying the general physiology-based theory of dynamic energy budgets, the evolutionary rules governing the body sizes of predators and their prey could be understood (Troost *et al.*, 2008).

Adaptive dynamics theory provides a natural mathematical framework for understanding the formation of biological diversity, one of the key determinants of ecosystem functioning. Many of the recent developments in this area have originated from the EEP program. Three EEP studies now further clarify the eco-evolutionary dynamics of biological diversification (Heinz *et al.*, 2008; Leimar *et al.*, 2008; Pennings *et al.*, 2008).

Adaptive dynamics theory provides an extension of classical evolutionary game theory and therefore has great potential for application in other areas, also outside the biological context, that traditionally rely on game-theoretical methods. This holds for the adaptation of social behavioral in general and for economic behavior in particular. In this vein, Dercole *et al.* (2008) have demonstrated how to harness adaptive dynamics theory to improve understanding of the processes of technological in-

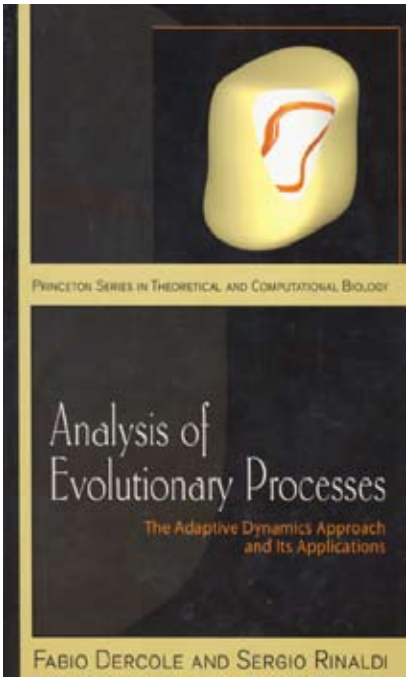


Figure 1. IIASA publishes the first textbook on adaptive dynamics theory.

novation and diversification. This latter study is based on collaborative research carried out by EEP together with IIASA's Forestry Program.

Evolutionary Fisheries Management

EEP's research on fisheries-induced evolution is designed to overcome a blind spot in the management of living aquatic resources: exploitation not only changes the abundance of fish, but also their traits. In pursuing this goal, EEP adopts a threefold approach.

A first element is the development of innovative methodological tools suitable for tackling the new research questions. To understand the effects fishing exerts on adaptive traits, methods to quantify selection pressures have been refined (Arlinghaus *et al.*, submitted). To predict the future ecology and evolution of exploited fish stocks, to understand observed past changes, and to evaluate the merits of alternative management strategies, a novel class of eco-genetic models has been devised (Dunlop *et al.*, 2009a, 2009b), and adaptive dynamics models have been extended (Ernande *et al.*, in press). To analyze trends in the maturation schedules of exploited fish stocks, so-called probabilistic maturation reaction norms were introduced and estimated from data (Heino and Dieckmann, 2008a, 2008b; Heino *et al.*, in revision). It was also demonstrated that methods previously proposed in the literature for extracting life-history information from individual growth observations requires further scrutiny (Baulier and Heino, 2008).

As a second element, these new tools are applied to case studies on particular stocks. The steady pace of work along this line of research continued in 2008, with dedicated studies targeting brook charr/trout in Canadian creeks and lakes (Thériault *et al.*, 2008; Okamoto *et al.*, in revision), Arctic charr in Norway (Primicerio *et al.*, in revision), Atlantic salmon in Finland (Vainikka *et al.*, submitted), northern pike in Europe (Arlinghaus *et al.*, submitted), Atlantic cod in the Gulf of St. Lawrence (Heino *et al.*, 2008a), Atlantic cod in Iceland (Pardoe *et al.*, in revision), Atlantic cod in the Barents Sea (Eikeset *et al.*, in preparation), plaice in the North Sea (Mollet *et al.*, in preparation), chum salmon in Korea (Urbach *et al.*, in preparation), and sockeye salmon in Alaska (Kendall *et al.*, in preparation). Many of these recent studies target salmonids; insights into the fisheries-induced evolution of salmonids obtained with earlier methods were reviewed by Hard *et al.* (2008).

A third element is provided by strategic studies designed to address basic open questions regarding fisheries-induced evolution. Recent progress includes an investigation of the propensity of marine reserves to slow the evolutionary effects of fishing (Dunlop *et al.*, submitted; Miethe *et al.*, submitted), a study of the impacts of gear selectivity on the fisheries-induced evolu-

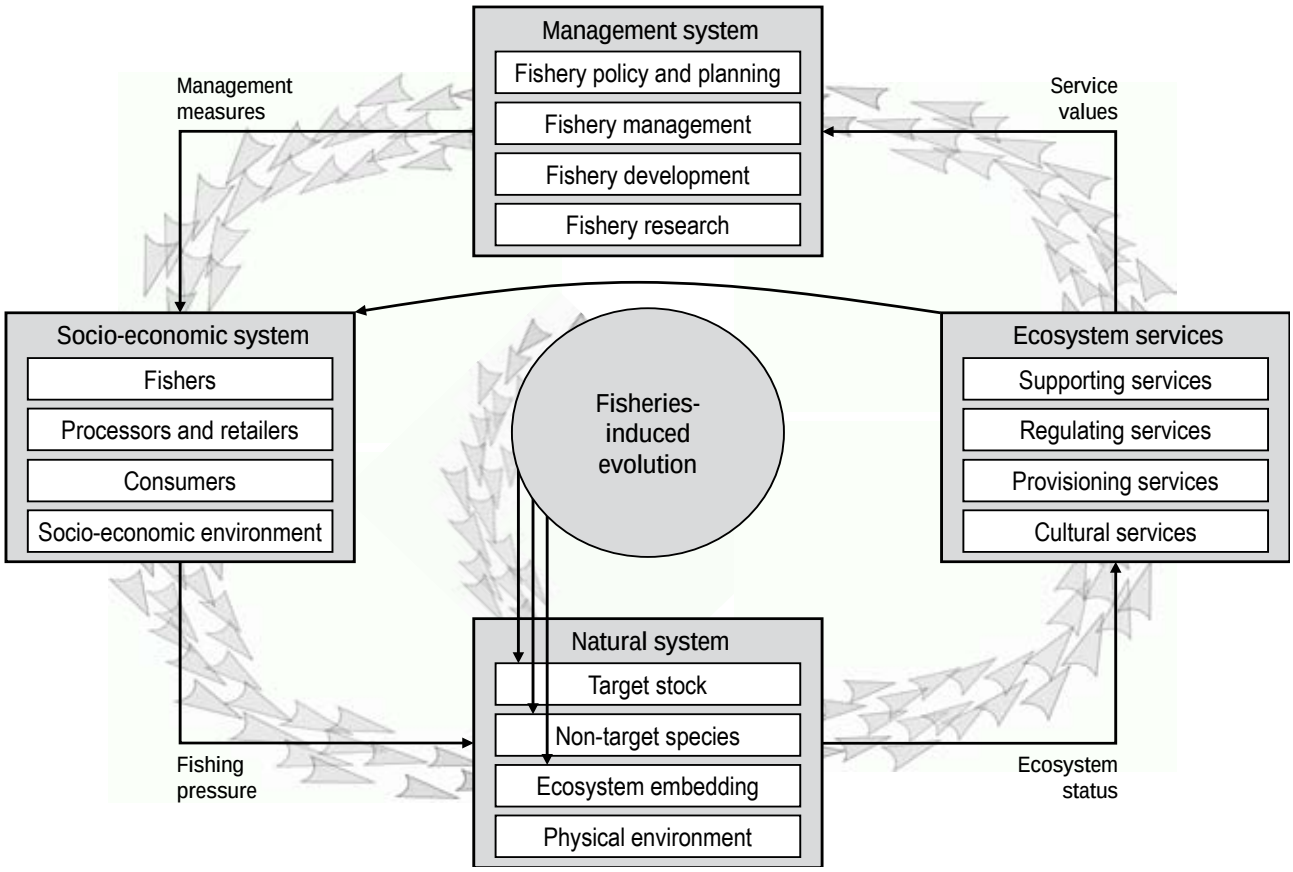


Figure 2. The effects of fisheries-induced evolution cascade through the fishery system, as indicated by the flow of triangular arrows.

tion of life-history traits (Boukal *et al.*, 2008), new analyses of the practical implications of sex structure and mate choice for fisheries-induced evolution (Mollet *et al.*, in preparation; Urbach and Cotton, 2008; Urbach *et al.*, in preparation; Taborsky *et al.*, 2008), and systematic investigations of the ecological and evolutionary aspects of recovery in collapsed fish stocks (Enberg *et al.*, 2009). Studies on salmonids in the Baltic drainage focused on the interactions between wild and stocked fish (Nilsson *et al.*, 2008) and on the survival of adult sea trout in rivers (Östergren and Rivinoja, 2008)—a feature that critically influences the evolution of iteroparity and is sensitive to negative anthropogenic effects. At a more fundamental level, investigations have examined the effects of gonadal alterations on offspring viability (Urbach *et al.*, 2008) and determinants of abundance fluctuations of a species at the margins of its geographical range (Heino *et al.*, 2008b).

EEP's lengthy investment in elucidating the evolutionary implications of fishing (Dieckmann *et al.*, in preparation) is attracting increasing attention among scientists charged with providing advice to fisheries managers. First, coverage of the evolutionary implications of fishing is now starting to appear in textbooks and encyclopedias (Heino and Dieckmann, 2008b, 2009). Second, the Study Group on Fisheries-Induced Adaptive Change (SGFIAC), established in 2006 by the International Council for the Exploration of the Sea (ICES), is addressing scientific and applied dimensions of fisheries-induced evolution (ICES, 2008). In 2007 the group jointly prepared an article in the Policy Forum of *Science*, which received wide attention and triggered lively debate that continued in 2008 (Jørgensen *et al.*, 2008). Following its annual meeting in 2008, the group is currently preparing manuscripts on evolutionary impact assessments (EvoIAs; Laugen *et al.*, in preparation) and on the influence fisheries-induced evolution has on reference points commonly used in fisheries management (Heino *et al.*, in preparation). Third, EEP co-organized the symposium "Evolving Fish, Changing Fisheries" at the American Fisheries Society's 2008 annual conference in Ottawa, attracting a wide range of fisheries scientists, managers, and stakeholders.

Evolution of Cooperation

EEP's research on the evolution of cooperation continues to unravel conditions promoting unselfish behavior in groups of unrelated agents. This challenge—widely studied under titles such as the "tragedy of the commune," "public goods games," or "social dilemmas"—is a highly interdisciplinary topic that attracts considerable general interest.

Kun and Dieckmann (in revision) and Kun and Scheuring (2009) highlighted the importance of resource heterogeneity for enhancing cooperative behavior, thus drawing attention to a ubiquitous feature of natural resource distributions that curiously has been overlooked thus far.

Enforcement of cooperation is a hotly debated topic. Richter *et al.* (in preparation) explored a model for the evolution of social norms regulating the exploitation of renewable resources. Nakamaru and Dieckmann (2009) introduced and analyzed a model for the runaway selection of "strict and severe" punishment enforcing cooperation. Hauert *et al.* (2008, in press) highlighted the importance of voluntary rather than compulsory participation for the evolution of cooperation. In particular the issue of strong versus weak altruism has been addressed in this context. Traulsen *et al.* (2009) showed why increasing the rate at which errors are made in a cooperation game qualitatively changes the game's outcome: cooperation and punishment can be established by high error rates. In a more institutionalized setting, Colombo and Rinaldi (2008) showed how even in the simplest two-party democracies voting procedures can lead to chaotic evolution. Uchida and Sigmund (submitted) analyzed competition among several assessment rules for fostering indirect reciprocity. As such rules can be viewed as rudimentary moral systems, this work is likely to stimulate further methodological progress.

Significantly, the monograph *The Calculus of Selfishness* was completed in 2008 and will be published by Princeton University Press in 2009 (Sigmund, 2009).

Evolving Biodiversity

Understanding the mechanisms underlying the emergence, maintenance, and loss of biodiversity remains a major challenge for evolutionary ecology and conservation science. EEP contributes to the resultant efforts in a variety of ways. First is research on the ecological and genetic conditions promoting the formation of biodiversity (Heinz *et al.*, 2008; Leimar *et al.*, 2008; Mazzucco *et al.*, submitted; Pennings *et al.*, 2008; Ravigné *et al.*, 2009; Troost *et al.*, 2008).

In 2008 EEP focused on investigating the evolutionary establishment and subsequent stability of food webs. Gross *et al.* (in revision) found two new general rules for determining food-web stability, which is enhanced when species at high trophic level feed on multiple prey species and when species at intermediate trophic level are fed upon by multiple predator species. In addition, EEP has made a number of advances in extending food-web theory (Rossberg, 2008a; Rossberg *et al.*, 2008a, 2008b, 2009). An exciting recent result is the demonstration that certain empirical observations of natural food webs do not imply, as was previously believed, that the niche spaces in which food webs are structured are merely one-dimensional. This finding is likely to free future food-web analyses from the erroneous assumption that only the body sizes of individuals structure feeding interactions (Rossberg *et al.*, submitted). Several further studies dealt with observable patterns of ecological communities (Colombo *et al.*, 2008; Serizawa *et al.*, 2008a, 2008b; Vaz *et al.*, 2008). A specific result that may be worth highlighting here is that intermediate levels of landscape disturbances maximize the number of individuals that can live in a fragmented environment (Kun *et al.*, in revision). The reason is that random fluctuations in habitat quality have not only negative effects by destroying habitable patches, but also positive effects by connecting previously disparate clusters of patches. Moreover, a new framework for analyzing evolutionary community responses to extinctions (Johansson and Dieckmann, 2009) showed under what conditions ecological communities may be restored through gradual evolution after extinctions, a finding with wide-ranging implications for understanding patterns of biodiversity change.

Two additional studies derived novel evolutionary predictions for delayed germination and energy allocation in stochastic environments (Metz *et al.*, 2009; Fischer *et al.*, 2009). Cobey *et al.* (in revision) examined the factors that drive the evolution of influenza's host range. Since the influenza virus is known to jump species, including transitions from animals to humans, it is important to understand what conditions put the human population at high or low risk of such zoonotic emergences of disease outbreaks. This was complemented by an investigation of the influence of the structure of social contact networks on disease dynamics (Peyrard *et al.*, 2008).

Next Steps

Coordination and research efforts in 2009 will focus on the following activities:

- Intensive research on the European Research Network "Fisheries-induced Evolution" (FinE), which involves 18 international research institutions coordinated by IIASA from 2007 to 2010.
- Conclusion of the European Research Training Network "Fisheries-induced Adaptive Changes in Exploited Stocks" (FishACE), which has brought together 11 international research institutions coordinated by IIASA from 2005 to 2009.
- Organization of activities within the Research Networking Programme, *Frontiers of Speciation Research* (FroSpects), supported by 15 national research agencies and coordinated by IIASA from 2008 to 2013.
- Convening the international IIASA conference "Evolution of Cooperation: Models and Theories," as part of the EURO-CORES Programme, "The Evolution of Cooperation and Trading" (TECT), supported by the European Science Foundation.
- Completion of two books to be published by Cambridge University Press, entitled *Fisheries-induced Adaptive Change* (Dieckmann *et al.*, in preparation) and *Elements of Adaptive Dynamics* (Dieckmann and Metz, in preparation).
- Continued collaborative research with the YSSP award winners Daniel Falster (2006), Andries Richter (2007), and Jan Ohlberger (2008).
- Methodological research on the integration of adaptive dynamics theory with dynamic programming and on simplifying spatial complexity through moment dynamics (the latter in collaboration with IIASA's Dynamic Systems Project).
- Development of stock-specific, multi-trait, eco-genetic models for Icelandic cod (in collaboration with Icelandic colleagues) and North Sea plaice (in collaboration with Dutch colleagues).
- Case studies on Caspian sturgeon (in collaboration with Russian and Iranian colleagues), Korean chum salmon and Pacific sardine (in collaboration with South Korean colleagues), Alaskan sockeye salmon (in collaboration with colleagues from the United States), and orange roughy (in collaboration with Canadian colleagues).
- Development of a detailed definition of evolutionary impact assessments (EvoIAs); evaluation of the evolutionary vulnerability of specific stocks; integration of genetic information into analyses of fisheries-induced evolution; study of the evolutionary consequences of harvesting at the ecosystem level; and further explorations of the interactions between fisheries-induced evolution, environmental fluctuations, Allee effects, and the collapse and recovery of fish stocks.
- Work on innovative harvest control rules for fisheries management and on the integrated assessment and resolution of stakeholder conflicts in fisheries management.
- Research on the evolution of cooperation, including the beneficial or adverse effects of resource heterogeneity, the tragedy of the commune in public goods games, and on vicious cycles of exuberance, vulnerability, and collapse in the evolution of cooperative investment strategies.
- Investigation of new and more realistic models of the evolutionary community assembly of ecological food webs and of speciation processes in spatially structured environments.
- Research on evolutionary-ecology vegetation models and, thereby, on an evolutionary foundation of dynamic global vegetation models (in collaboration with Australian colleagues).

Scientific Recognition: Editorships

Ulf Dieckmann
Editorial Board, *Theoretical Ecology*

Mikko Heino
Editor, *Ecology Letters*

Johan A.J. Metz
Editorial Board, *Acta Biotheoretica*

Karl Sigmund
Editorial Board, *Journal of Theoretical Biology*
Associate Editor, *Theoretical Population Biology*
Editorial Board, *International Journal of Bifurcation and Chaos*
Co-editor in Chief, *International Journal of Biomathematics*
Editorial Board, *Philosophical Transactions of the Royal Society B*

Scientific Recognition: Invited Lectures

Mats Bodin

1. Bergen, Norway: Annual Meeting of the European Research Training Network on Fisheries-induced Adaptive Changes in Exploited Stocks (FishACE): Evolutionary responses to harvesting of size-at-maturation in predator-prey systems
2. Saint Jean de Luz, France: Annual Meeting of the European Research Network on Fisheries-induced Evolution (FinE): Evolutionary responses to harvesting in predator-prey systems
3. Department of Mathematics, University of Umeå, Umeå, Sweden: Evolutionary responses of size-at-maturation to harvesting in predator-prey systems
4. Lund University, Lund, Sweden: Workshop on the Population Dynamical Consequences of Harvesting-induced Adaptive Evolution of the European Research Training Network on Fisheries-induced Adaptive Changes in Exploited Stocks (FishACE): Evolutionary responses of size-at-maturation and population dynamics to harvesting in predator-prey systems

Gergely Boza

1. Oeiras, Portugal: Workshop "Towards Unifying Theory of Cooperation and Mutualism" of the European Research Network on The Evolution of Cooperation and Trading (TECT): Partner choice and partner fidelity in spatial models of mutualism
2. Obernai, France: Summer School of the European Research Network on The Evolution of Co-operation and Trading (TECT): The evolution and stability of mutualism in a continuous game theoretical model

Åke Brännström

1. Macquarie University, Sydney, Australia: Symposium and Workshop "Towards an Evolutionary Ecology Vegetation Model (EEVM)": Evolutionary assembly of size-structured food webs
2. Bergen, Norway: Annual Meeting of the European Research Training Network on Fisheries-induced Adaptive Changes in Exploited Stocks (FishACE): Harvest-induced extinctions in models of evolutionarily assembled food webs
3. Academy of Science and Letters, Oslo, Norway, Workshop "The Red Queen Hypothesis": Red Queen evolution in models of food web assembly

Ulf Dieckmann

1. University of Leuven, Leuven, Belgium: Symposium "A Future for Fisheries? Towards Effective Strategies for Sustainability": The overlooked evolutionary dimension of modern fisheries
2. Macquarie University, Sydney, Australia: Symposium and Workshop "Towards an Evolutionary Ecology Vegetation Model (EEVM)": 1) Frequency-dependent selection and coevolution as key elements of ecosystem evolution; and 2) Ecologically driven evolutionary diversification
3. Ottawa, Canada: Symposium "Evolving Fish, Changing Fisheries" at the Annual Meeting of the American Fisheries Society: Eco-genetic models of fisheries-induced evolution
4. University of Bergen, Bergen, Norway: Workshop "Socioeconomic Effects of Fisheries-induced Evolution": Eco-genetic models
5. University of Sheffield, Sheffield, United Kingdom: Workshop "Challenges of Speciation": Adaptive speciation and the formation of biodiversity
6. Saint Jean de Luz, France: Annual Meeting of the European Research Network on Fisheries-induced Evolution (FinE): 1) Fisheries-induced evolution of life-history prototypes; and 2) Ecological and evolutionary recovery of exploited stocks

Varvara Fazalova

1. Gamlitz, Austria: Meeting of the European Research Network on Molecular Archives of Climatic History (MOLARCH): Baikalian genetic diversity with respect to past environmental changes

Barbara Fischer

1. University of Lausanne, Lausanne, Switzerland: Optimal resource allocation in fluctuating environments

Mikko Heino

1. Maastricht, Netherlands: Workshop "Management of Fisheries-induced Adaptive Changes" of the European Research Training Network on Fisheries-induced Adaptive Changes in Ex-ploited Stocks (FishACE): Stock assessment: Statistical methods
2. Bergen, Norway: Annual Meeting of the European Research Training Network on Fisheries-induced Adaptive Changes in Exploited Stocks (FishACE): Trends in maturation reaction norms of Northeast Arctic cod
3. Ottawa, Canada: Symposium "Evolving Fish, Changing Fisheries" at the Annual Meeting of the American Fisheries Society: Empirical evidence for fisheries-induced evolution in the wild

4. Halifax, Canada: Annual Science Conference of the International Council for the Exploration of the Sea (ICES): 1) Size structure, age-size dynamics, and life history variation; 2) Length structure of deep-pelagic fishes sheds new light to their life histories; and 3) Gear selectivity and life history evolution
5. Saint Jean de Luz, France: Annual Meeting of the European Research Network on Fisheries-induced Evolution (FinE): 1) Fisheries-induced changes in Atlantic cod in the Barents Sea; 2) Fisheries-induced life-history changes in herring; and 3) Fisheries-induced changes in Atlantic salmon
6. Valencia, Spain: World Conference in Marine Biodiversity: Exploitation-driven evolution and marine biodiversity

Jakob Johansson

1. Macquarie University, Sydney, Australia: Symposium and Workshop "Towards an Evolutionary Ecology Vegetation Model (EEVM)": Evolutionary responses to environmental changes: how does competition affect adaptation?
2. Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany: Predicting strategic variation within plant communities: An evolutionary approach
3. Leipzig, Germany: EURECO-GFOE 2008 Conference on Biodiversity in an Ecosystem Context: Predicting strategic variation within plant communities: An evolutionary approach
4. Department of Mathematics, University of Umeå, Umeå, Sweden: Predicting strategic variation within plant communities: An evolutionary approach

Fiona Johnston

1. Ottawa, Canada: Symposium "Evolving Fish, Changing Fisheries" at the Annual Meeting of the American Fisheries Society: Integrating stakeholder perspectives with management objectives: A modeling approach for recreational fisheries
2. International Fishing Hall of Fame, Dania, USA: Symposium "Understanding the Angler and Societal Perceptions" at the World Recreational Fisheries Conference: Integrating angler behavior and fish population dynamics: Implications for recreational fisheries management

Ádám Kun

1. Oeiras, Portugal: Workshop "Towards Unifying Theory of Cooperation and Mutualism" of the European Research Network on The Evolution of Cooperation and Trading (TECT): Space and heterogeneity: Their effects on mutualism
2. Villa Gualino, Turin, Italy: Third European PhD Complexity School of the ISI Foundation: 1) Evolution of cooperation on grids and graphs; and 2) Error threshold in the RNA world

Shuichi Matsumura

1. Stockholm, Sweden: Symposium "Complex Systems, Resource Management and Economic Development" at the Resilience 2008 Conference: Managing regional social-ecological systems of recreational fisheries with heterogeneous anglers
2. Ottawa, Canada,:Symposium "Evolving Fish, Changing Fisheries" at the Annual Meeting of the American Fisheries Society: Estimating selection strength on life-history traits in fish exploited by recreational fishing
3. University of Tokyo, Tokyo, Japan, Symposium "Adaptive Strategies" at the Annual Meeting of the Society of Population Ecology: Probabilistic patch choice, imperfect information, and travelling cost: An extension of the Ideal Free Distribution model
4. Pacifico Yokohama, Yokohama, Japan: Symposium "Inland Fisheries: The Hidden Crisis" at the Fifth World Fisheries Congress: Modeling the impact of inland recreational fisheries at regional scales by incorporating complex angler behavior
5. International Fishing Hall of Fame, Dania, USA: Symposium "Understanding the Angler and Societal Perceptions" at the World Recreational Fisheries Conference: Understanding fish–angler interactions at a landscape level to improve fisheries management

Johan A.J. Metz

1. Institut Henri Poincaré, Paris, France: Workshop "Inhomogeneous Random Systems": Relating the effective population sizes of adaptive dynamics and random genetic drift
2. University of Helsinki, Helsinki, Finland: Relating the effective population sizes of adaptive dynamics and random genetic drift
3. University of Oslo, Oslo, Norway: The geometry of macro-evolution: contrasts and links between evo-devo and adaptive dynamics
4. University of Helsinki, Helsinki, Finland: The geometry of macro-evolution: Contrasts and links between evo-devo and adaptive dynamics
5. Biological Station, Paimpont, France: Workshop "Adaptive Dynamics of Parasitoids": The canonical equation of adaptive dynamics: Mendelian diploids and haplo-diploids

6. University of Edinburgh, Edinburgh, United Kingdom: Symposium "Adaptive Dynamics" at the European Conference on Mathematical and Theoretical Biology: Effective population sizes and the canonical equation of adaptive dynamics
7. Ghent, Belgium: Symposium "Theoretical Contributions of Evo-Devo to Evolutionary Theory" at the Second European Evo-Devo Conference of the European Society for Evolutionary Developmental Biology: Contrasting the contributions of evo-devo and adaptive dynamics to the postmodern synthesis
8. Academy of Science and Letters, Oslo, Norway: Workshop "The Red Queen Hypothesis": Conflict between alleles and modifiers in the evolution of genetic polymorphisms
9. University of Helsinki, Helsinki, Finland: When does evolution optimise?
10. Amphithéâtre Bourgogne, Paris, France: Workshop "R0 and Related Concepts: Methods and Illustrations": On a simple fitness proxy for ESS calculations in structured populations with continuous traits
11. Purdue University, West Lafayette, USA: Conference on Differential Equations and Applications in Ecology and Epidemiology: Effective population sizes and the canonical equation of adaptive dynamics

Johan Östergren

1. Bergen, Norway: Annual Meeting of the European Research Training Network on Fisheries-induced Adaptive Changes in Exploited Stocks (FishACE): Evolutionary consequences of fisheries and dams on life-history traits in Baltic Sea trout—an eco-genetic modeling approach
2. Saint Jean de Luz, France: Annual Meeting of the European Research Network on Fisheries-induced Evolution (FinE): Eco-genetic model of Baltic Sea trout

Sergio Rinaldi

1. University of Padua, Padua, Italy: Erasmus Seminar "Mathematical and Computational Models in the Psychological Sciences": Modeling love dynamics
2. Ecole Normale Supérieure, Paris, France: Spring School: 1) Environmental management and nonlinear dynamics; 2) The problem of floating plants in reservoirs; 3) Forest exploitation and acid rain: A dangerous mix; 4) The reclamation of entropic water bodies; 5) Tourism sustainability: An overview; and 6) Enrichment and yield maximization
3. Institut d'Études Scientifiques, Corsica, France: International Workshop "Chaos and Dynamics in Biological Networks": Synchrony in slow-fast metacommunities
4. University of Siena, Certosa di Pontignano, Italy: Tuscan Summer Academy on Mind Force: Mathematical models in human sciences

Axel Rossberg

1. University of York, York, United Kingdom: May '72 was right: Universal power laws in fish diet partitioning
2. Hungarian Academy of Sciences, Budapest, Hungary: The physics of food webs
3. Department of Mathematics, Hokkaido University, Sapporo, Japan: JST Presto Symposium on Mathematical Sciences towards Environmental Problems: The problem of biodiversity
4. Milwaukee, USA: Annual Meeting of the Ecological Society of America: May '72 was right: Universal diet partitioning by marine fish and squid

Karl Sigmund

1. University of Helsinki, Helsinki, Finland: Direct and indirect reciprocity
2. University of Helsinki, Finland: Colloquium of the Finnish Mathematical Society: Emergence of cooperation
3. German Academy of Sciences, Halle, Germany: Öffentliche Güter und die Bestrafung von Trittbrettfahrern
4. Urania, Graz, Austria: Öffentliche Güter und die Bestrafung von Trittbrettfahrern
5. University of Vienna, Vienna, Austria: Zwischen Zwang und Freiwilligkeit—die Evolution der Kooperation
6. Initiativkolleg, Leipzig, Germany: Emergence of cooperation
7. Swiss Federal Institute of Technology, Lausanne, Switzerland: Emergence of cooperation
8. Princeton University, Princeton, USA: Templeton Meeting: 1) Emergence of cooperation; and 2) Public goods and incentives
9. Ecole Normale Supérieure, Paris, France: Spring School: Evolution of cooperation
10. Wroclaw, Poland: Conference on Game Dynamics: Public goods and incentives
11. San Lorenzo de El Escorial, Spain: Summer course "Mathematics of Society: Cooperation, Social Networks and Complexity": Evolution of cooperation

12. Montreal, Canada: Congress on Mathematics of Life Sciences of the Society of Industrial and Applied Mathematics (SIAM): Coercion and the emergence of cooperation
13. Obernai, France: Summer School of the European Research Network on The Evolution of Co-operation and Trading (TECT): Evolution of cooperation
14. Stockholm School of Economics, Stockholm, Sweden: Public goods games between freedom and enforcement
15. University of Bielefeld, Bielefeld, Germany: Zwischen Zwang und Freiwilligkeit: Spieltheoretische Modelle zur Evolution der Kooperation

Barbara Taborsky

1. Cornell University, Ithaca, USA: Symposium "Cooperation and Conflict" at the 12th International Behavioral Ecology Congress: Early social environment determines social competence in a cooperative breeder

Davnah Urbach

1. International Council for the Exploration of the Sea (ICES) headquarters, Copenhagen, Denmark: Annual Meeting of the ICES Study Group on Fisheries Induced Adaptive Changes (SGFIAC): Ecological implications of non-random mating in fish
2. Maastricht, the Netherlands: Workshop "Management of Fisheries-induced Adaptive Changes" of the European Research Training Network on Fisheries-induced Adaptive Changes in Exploited Stocks (FishACE): Ecology and evolution of female mating preference under size-selective fishing
3. Bergen, Norway: Annual Meeting of the European Research Training Network on Fisheries-induced Adaptive Changes in Exploited Stocks (FishACE): Ecology and evolution of female mating preference under size-selective fishing
4. Ottawa, Canada: Symposium "Evolving Fish, Changing Fisheries" at the Annual Meeting of the American Fisheries Society: Ecology and evolution of female mating preference under size selective fishing
5. Saint Jean de Luz, France: Annual Meeting of the European Research Network on Fisheries-induced Evolution (FinE): Ecology and evolution of female mating preference under size-selective fishing
6. University of Vermont, Burlington, USA: Sexual selection in harvested populations: Evolution of female mating preference under size-selective fishing

Rebecca Whitlock

1. Maastricht, the Netherlands: Workshop "Management of Fisheries-induced Adaptive Changes" of the European Research Training Network on Fisheries-induced Adaptive Change in Exploited Stocks (FishACE): Eco-genetic modelling for Caspian Sea sturgeon stocks
2. Bergen, Norway: Annual Meeting of the European Research Training Network on Fisheries-induced Adaptive Change in Exploited Stocks (FishACE): Eco-genetic modelling for Caspian Sea sturgeon stocks
3. Saint Jean de Luz, France: Annual Meeting of the European Research Network on Fisheries-induced Evolution (FinE): 1) Fisheries-induced multi-trait evolution; and 2) Developing an eco-genetic model of Caspian Sea sturgeon stocks
4. Presidential Palace No 2, Almaty, Kazakhstan: Third Caspian Dialog: Fisheries-induced evolution and sustainable management for Caspian Sea sturgeon fisheries

References

Arlinghaus, R., Matsumura, S., Dieckmann, U. Quantifying selection pressures caused by recreational fishing, submitted

Baulier, L., Heino, M., 2008. Norwegian spring-spawning herring as the test case of piecewise linear regression method for detecting maturation from growth patterns. IIASA Interim Report IR-08-070 and *Journal of Fish Biology* 73: 2452–2467

Beham, B., Sigmund, K., 2008. A short tale of two cities: Otto Schreier and the Hamburg–Vienna connection. *Mathematical Intelligencer* 30: 27–35

Boukal, D.S., Dunlop, E.S., Heino, M., Dieckmann, U., 2008. Fisheries-induced evolution of body size and other life history traits: The impact of gear selectivity. *ICES CM* 2008/F: 07

Cobey, S., Pascual, M., Dieckmann, U. Ecological factors driving the long-term evolution of influenza's host range, in revision

Colombo, A., Rinaldi, S., 2008. Chaos in two-party democracies. *IIASA Interim Report IR-08-078* and *International Journal of Bifurcation and Chaos* 18: 2133–2140

Colombo, A., Dercole, F., Rinaldi, S., 2008. Remarks on metacommunity synchronization with application to prey-predator systems. *IIASA Interim Report IR-08-077* and *American Naturalist* 171: 430-442

Dercole, F., Rinaldi, S., 2008. *Analysis of Evolutionary Processes: The Adaptive Dynamics Approach and Its Applications*. Princeton University Press, 352pp

Dercole, F., Dieckmann, U., Obersteiner, M., Rinaldi, S., 2008. Adaptive dynamics and technological change. *Technovation* 28: 335–348

Dieckmann, U., Metz, J.A.J. (eds.), *Elements of Adaptive Dynamics*. Cambridge University Press, in preparation

Dieckmann, U., Godø, O.R., Heino, M., Mork, J. (eds.), *Fisheries-induced Adaptive Change*. Cambridge University Press, in preparation

Dunlop, E.S., Baskett, M.L., Heino, M. Dieckmann, U. Propensity of marine reserves to reduce the evolutionary effects of fishing in a migratory species, submitted

Dunlop, E.S., Heino, M., Dieckmann U., 2009a. Eco-genetic modeling of contemporary life-history evolution. *Ecological Applications*, in press

Dunlop, E.S., Heino, M., Dieckmann, U., 2009b. Eco-genetic models of fisheries-induced adaptive change. IIASA Interim Report IR-08-079 and in U. Dieckmann, O.R. Godø, M. Heino, J. Mork (eds.), *Fisheries-induced Adaptive Change*, Cambridge University Press, in press

Durinx, M., Metz, J.A.J., Meszéna, G., 2008. Adaptive dynamics for physiologically structured population models. *Journal of Mathematical Biology* 56: 673–742

Eikeset, A.M., Dunlop, E.S., Heino, M., Godø, O.R., Stenseth, N.C., Dieckmann, U. Harvest-induced evolution of multiple life-history traits in Atlantic cod, in preparation

Enberg, K., Dunlop, E.S., Jørgensen, C., Heino, M., Dieckmann, U., 2009. Implications of fisheries-induced evolution for stock rebuild-ing and recovery. *Evolutionary Applications*, in press

Ernande, B., Dieckmann, U., Heino, M. The adaptive dynamics of reaction norms. IIASA Interim Report IR-08-080 and in U. Dieckmann, O.R. Godø, M. Heino, J. Mork (eds.), *Fisheries-induced Adaptive Change*, Cambridge University Press, in press

Fischer, B, Taborsky, B., Dieckmann, U., 2009. Unexpected patterns of plastic energy allocation in stochastic environments. *IIASA Interim Report IR-08-035* and *American Naturalist* 173: E108-E120

Gross, T., Rudolf, L., Levin, S.A., Dieck-mann, U. Two rules for determining food-web stability, in revision

Hard, J., Gross, M.R., Heino, M., Hilborn, R., Kope, R.G., Law, R., Reynolds, J.D., 2008. Evolutionary consequences of fishing and their implications for salmon. *IIASA Interim Report IR-08-072* and *Evolutionary Applications* 1: 388–408

Hauert, C., Traulsen, A., De Silva (née Brandt), H., Nowak, M.A., Sigmund, K., 2008. Public goods with punishment and abstaining in finite and infinite populations. *IIASA Interim Report IR-08-075* and *Biological Theory* 3: 114–122

Heino, M., Dieckmann, U., 2008a. Detecting fisheries-induced life-history evolution: An overview of the reaction norm approach. *IIASA Interim Report IR-08-056* and *Bulletin of Marine Science* 83: 69-93

Heino, M., Dieckmann, U., 2008b. Evolution and sustainability of harvested populations. IIASA Interim Report IR-08-055 and in S.P. Carroll and C. Fox (eds.), *Conservation Biology: Evolution in Action*, Oxford University Press, pp. 308–323

Heino, M., Dieckmann, U., 2009. Fisheries-induced evolution. *IIASA Interim Report IR-08-081* and in *Encyclopedia of Life Sciences*, article no. A21213, John Wiley and Sons, in press

Heino, M., Baulier, L., Boukal, D., Dunlop, E.S., Eliassen, S., Enberg, K., Jørgensen, C., Varpe, Ø., 2008a. Evolution of growth in Gulf of St Lawrence cod? *Proceedings of the Royal Society London Series B* 275: 1111–1112

Heino, M., Engelhard, G.H., Godø, O.R., 2008b. Migrations and hydrography determine the abundance fluctuations of blue whiting (Micromesistius poutassou) in the Barents Sea. *IIASA Interim Report IR-08-071* and *Fisheries Oceanography* 17: 153–163

Heino, M., Ernande, B., Dieckmann, U. Reaction-norm analysis of fisheries-induced adaptive change. In: U. Dieckmann, O.R. Godø, M. Heino, J. Mork (eds.), *Fisheries-induced Adaptive Change*, Cambridge University Press, in revision

Heino M, *et al*. Can fisheries-induced evolution shift reference points for fisheries management?, in preparation

Heino M., Parvinen, K., Dieckmann, U., 2008c. Evolution of foraging strategies on resource gradients. *IIASA Interim Report IR-08-054* and *Evolutionary Ecology Research* 10: 1131–1156

Heinz, S., Mazzucco, R., Dieckmann, U., 2009. Speciation and the evolution of dispersal along environmental gradients. *IIASA In-terim Report IR-08-053* and *Evolutionary Ecology* 23: 53–70

ICES [International Council for the Exploration of the Sea] 2008. Report of the Study Group on Fisheries-Induced Adaptive Change (SGFIAC). ICES CM 2008/RMC: 01

Johansson, J., Dieckmann U., 2009. Evolutionary community responses to extinctions. *Evolutionary Ecology Research*, in press

Jørgensen, C., Enberg, K., Dunlop, E.S., Arlinghaus, R., Boukal, D., Brander, K., Ernande, B., Gårdmark, A., Johnston, F., Matsumura, S., Pardoe, H., Raab, K., Silva, A., Vainikka, A., Dieckmann, U., Heino, M., Rijnsdorp, A.D. 2008. The role of fisheries-induced evolution—Response. *IIASA Interim Report IR-08-073* and *Science* 320: 48–50

Kendall, N., Heino, M., Dieckmann, U. Understanding age and size at maturation of multiple sockeye salmon spawning populations of Bristol Bay, Alaska, using probabilistic maturation reaction norms, in preparation

Kumar, P., Hiremath, U.S., Yelamaggad, C.V., Rossberg, A.G., Krishnamurthy, K.S., 2008. Drifting periodic structures in a degenerate-planar bent-rod nematic liquid crystal beyond the dielectric inversion frequency. *IIASA Interim Report IR-08-064* and *Journal of Physical Chemistry B* 112: 9270–9274

Kumar, P., Hiremath, U.S., Yelamaggad, C.V., Rossberg, A.G., Krishnamurthy, K.S., 2008. Electroconvection in a homeotropic bent-rod nematic liquid crystal beyond the dielectric inversion frequency. *IIASA Interim Report IR-08-063* and *Journal of Physical Chemistry B* 112: 9753-9760

Kun, Á., Dieckmann, U. Resource heterogeneity can facilitate cooperation, in revision

Kun, Á., Scheuring, I., 2009. Evolution of cooperation on dynamical graphs. *IIASA Interim Report IR-08-060* and *Biosystems* 96: 65–68

Kun, Á., Oborny, B., Dieckmann, U. Intermediate landscape disturbance maximizes metapopulation size, in revision

Laugen, A.T., *et al*. Evolutionary impact assessment: How to account for evolutionary consequences of fishing in ecosystem-based fisheries management, in preparation

Leimar, O., Doebeli, M., Dieckmann, U., 2008. Evolution of phenotypic clusters through competition and local adaptation

along an environmental gradient. *IIASA Interim Report IR-08-050* and *Evolution* 62: 807–822

Mazzucco, R., Fazalova, V., Dieckmann, U. Adaptive parapatric speciation. In: U. Dieckmann, J.A.J. Metz (eds.), *Elements of Adaptive Dynamics*, Cambridge University Press, submitted

Metz, J.A.J., 2008. Fitness. In: S.E. Jørgensen (ed.), *Encyclopedia of Ecology*, pp. 1599–1612, Elsevier

Metz, J.A.J., Klinkhamer, P.G.L., de Jong, T.J., 2009. A different model to explain delayed germination. *IIASA Interim Report IR-08-059* and *Evolutionary Ecology Research*, in press

Metz, J.A.J., Mylius, S.D., Diekmann, O., 2008a. When does evolution optimise? *IIASA Interim Report IR-08-013* and *Evolutionary Ecology Research* 10: 629–654

Metz, J.A.J., Mylius, S.D., Diekmann, O., 2008b. Even in the odd cases when evolution optimises, unrelated population dynamical details may shine through in the ESS. *IIASA Interim Report IR-08-014* and *Evolutionary Ecology Research* 10: 655–666

Metz, J.A.J. Invasion fitness in population genetics. In: U. Dieckmann and J.A.J. Metz (eds.), *Elements of Adaptive Dynamics*, Cambridge University Press, submitted

Miethe, T., Dytham, C., Dieckmann, U., Pitchford, J. Marine reserves and the evolutionary effects of fishing on size at maturation, submitted

Mollet, F.M., Enberg, K., Boukal, D.S., Rijnsdorp, A.D., Dieckmann, U. The evolutionary significance of female dominated sexual size dimorphism: A study of plaice (*Pleuronectes platessa*), in preparation

Nakamaru, M., Dieckmann, U., 2009. Runaway selection for cooperation and strict-and-severe punishment. *IIASA Interim Report IR-08-082* and *Journal of Theoretical Biology* 257: 1–8

Nilsson, J., Östergren, J., Lundqvist, H., Carlsson, U., 2008. Genetic assessment of salmon and sea trout stocking in a Baltic Sea river. *IIASA Interim Report IR-08-041* and *Journal of Fish Biology* 73: 1201–1215

Okamoto, K.W., Whitlock, R., Magnan, P., Dieckmann, U. Mitigating fisheries-induced evolution in lacustrine brook trout (*Salvelinus fontinalis*) in southern Quebec, Canada, in revision

Östergren, J., Rivinoja, P., 2008. Overwintering and downstream migration of sea trout (*Salmo trutta L.*) kelts under regulated flows—northern Sweden. *IIASA Interim Report IR-08-057* and *River Research and Applications* 24: 551–563

Pardoe, H., Vainikka, A., Thórdarson, G., Marteinsdóttir, G., Heino, M. Temporal trends in probabilistic maturation reaction norms and growth of Atlantic cod (*Gadus morhua L.*) on the Icelandic shelf, submitted

Parvinen, K., Metz, J.A.J., 2008. A novel fitness proxy in structured locally finite metapopulations with diploid genetics, with an application to dispersal evolution. *IIASA Interim Report IR-08-058* and *Theoretical Population Biology* 73: 517–528

Pennings, P.S., Kopp, M., Meszéna, G., Dieckmann, U., Hermisson, J., 2008. An analytically tractable model for competitive speciation. *IIASA Interim Report IR-08-046* and *American Naturalist* 171: E44–E71

Peyrard, N., Dieckmann, U., Franc, A., 2008. Long-range correlations improve understanding the influence of network structure on contact dynamics. *IIASA Interim Report IR-08-044* and *Theoretical Population Biology* 73: 383–394

Primicerio, R., Amundsen, P.A., Heino, M., Knudsen, R., Svenning, M., Klemetsen, A. Fishing-induced evolution and recovery potential of Arctic charr maturation schedules in a whole-lake experiment, submitted

Ravigné, V., Dieckmann, U., Olivieri, I., 2009. Emergence of specialization: Joint evolution of local adaptation and habitat choice, in press

Richter, A., Brännström, Å., Dieckmann, U. The evolution of social norms for renewable resource exploitation, in preparation

Rossberg, A.G., 2008a. Part-whole relations between food webs and the validity of local food-web descriptions. I*IASA Interim Report IR-08-065* and *Ecological Complexity* 5: 121–131

Rossberg, A.G., 2008b, Laplace transforms of probability distributions and their inversions are easy on logarithmic scales. *Journal of Applied Probability* 45: 531–541

Rossberg, A.G., Brännström, Å., Dieckmann, U., 2009. How trophic interaction strength depends on traits: A conceptual framework for representing multidimensional trophic niche spaces. *IIASA Interim Report IR-08-083* and *Theoretical Ecology*, in press

Rossberg, A.G., Brännström, Å., Dieckmann, U. A new explanation for food-web intervality, submitted

Rossberg, A.G., Ishii, R., Amemiya, T., Itoh, K., 2008a. The top-down mechanism for body-mass-abundance scaling. *IIASA Interim Report IR-08-062* and *Ecology* 89: 567–580

Rossberg, A.G., Yoshida, K., Ishii, R., 2008b, Introduction to special section on current food-web theory. *IIASA Interim Report IR-08-074* and *Ecological Complexity* 5: 71–72

Serizawa, H., Amemiya, T., Enomoto, T., Rossberg, A.G., Itoh, K., 2008a. Mathematical modeling of colony formation in algal blooms: Phenotypic plasticity in cyanobacteria. *IIASA Interim Report IR-08-066* and *Ecological Research* 23: 841–850

Serizawa, H., Amemiya, T., Rossberg, A.G., Itoh, K., 2008b. Computer simulations of seasonal outbreak and diurnal vertical migration of cyanobacteria. *IIASA Interim Report IR-08-067* and *Limnology* 9: 185–194

Sigmund, K., 2009. *The Calculus of Selfishness*. Princeton University Press, in press

Taborsky, B., Guyer, L., Taborsky, M., 2009. Size-assortative mating in the absence of mate choice. IIASA *Interim Report IR-08-061* and *Animal Behaviour* 77: 439–448

Thériault, V., Dunlop, E.S., Dieckmann, U., Bernatchez, L., Dodson, J.J., 2008. The impact of fishing-induced mortality on the evolution of alternative life-history tactics in brook charr. *IIASA Interim Report IR-08-042* and *Evolutionary Applications* 1: 409–423

Traulsen, A., Hauert, C., De Silva, H., Nowak, M.A., Sigmund, K., 2009. Exploration dynamics in evolutionary games. *IIASA Interim Report IR-08-076* and *Proceedings of the National Academy of Sciences of the USA,* in press

Troost, T., Kooi, B., Dieckmann, U., 2008. Joint evolution of predator body size and prey-size preference. *Evolutionary Ecology* 22: 771–799

Uchida, S., Sigmund, K. The competition of assessment rules for indirect reciprocity, submitted

Urbach, D., Cotton, S., 2008. On the consequences of sexual selection for fisheries-induced evolution. *IIASA Interim Report IR-08-068* and *Evolutionary Applications* 1: 645–649

Urbach, D., Britschgi, A., Jacob, A., Bittner, D., Bernet, D., Wahli, T., Yoccoz, N.G., Wedekind, C., 2008. Gonadal alterations in male whitefish *Coregonus fatioi:* No evidence for genetic damage reducing viability in early life stages. *IIASA Interim Report IR-08-069* and *Diseases of Aquatic Organisms* 81: 119–125

Urbach, D., Heino, M., Kang, M., Kim, S., Dieckmann, U. Characterizing growth and maturation of Korean chum salmon from the Namdae River, in preparation

Vainikka, A., Kallio-Nyberg, I., Heino, M., Koljonen, M.L. Divergent trends in life-history traits between Atlantic salmon of wild and hatchery origin in the Baltic Sea, submitted

Vaz, S., Martin, C.S., Eastwood, P., Ernande, B., Charpentier, A., 2008. Modelling species distributions using regression quantiles. *Journal of Applied Ecology* 45: 204–217

Forestry Program

Sten Nilsson
nilsson@iiasa.ac.at

Introduction

Forests cover about one-third of the Earth's surface, producing food, fuel, medicines, and industrial raw material; they encompass most of the Earth's biodiversity, are crucial with respect to the climate issue both in the form of sequestration of carbon and as a source of bioenergy, and produce many ecological/environmental services. According to the World Bank, two billion people are dependent in one way or another on forests for survival, particularly the one billion people living in extreme poverty.

Three Research Themes

The overall objectives of IIASA's Forestry Program (FOR) research efforts during recent years have been the key challenges: 1) how to manage the forest sector in its interaction with other environmental and non-environmental sectors and thus harmonize its geo- and biosphere services; and 2) how to enable the forest sector to positively contribute to socioeconomic development. This objective is addressed from different perspectives by FOR's three *Research Themes:*

1. *Greenhouse Gas (GHG) Cycling and Terrestrial Ecosystems*, whose aim is to contribute to a better understanding of the exchange of GHG fluxes between terrestrial ecosystems and the atmosphere and how this understanding can be integrated into management decisions at various levels.
2. *Global Impacts of Forest Sector and Land Use Development in Emerging Economies*, which addresses the global impacts of the forest sectors in China, India, Brazil, Congo Basin, and the Koreas.
3. *International Governance of Forests*, which helps to improve international practices in forestry and to bring FOR research results into the sector's policy and governance processes.

Key Challenges and Related Research Topics

The following selected *Key Challenges* and related activities were the focus of FOR research during 2008:

- To understand the deforestation process and to investigate mechanisms for avoiding future deforestation;
- To assess the sustainable potential of biomass production for bioenergy and associated land use conflicts;
- To better understand GHG cycling in the terrestrial biosphere in the northern extra-tropical belt;

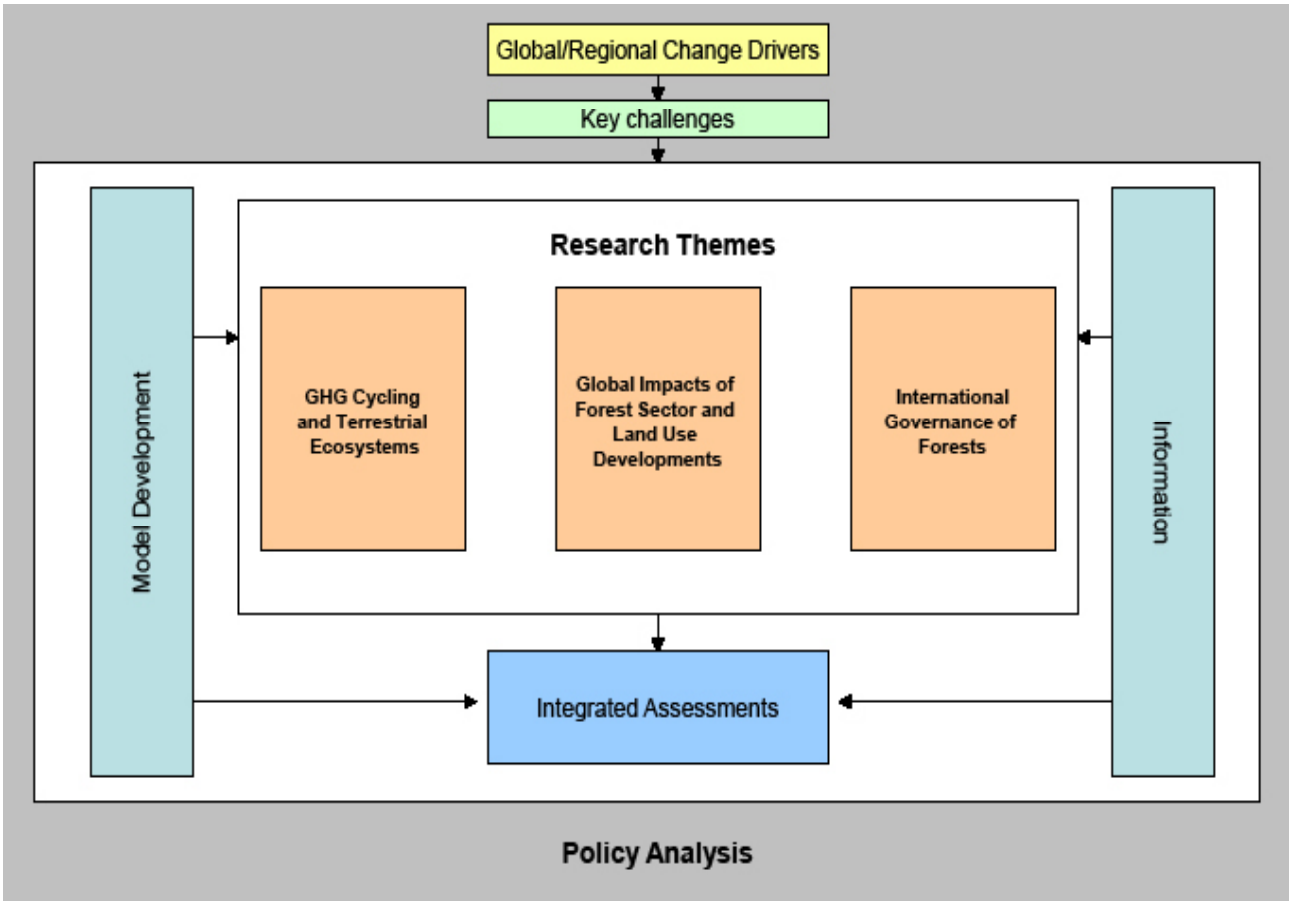


Figure 1. IIASA FOR Program's research structure.

- To assess the potential of improved ecosystem management with respect to GHG emissions and policy implications;
- To assess and quantify existing uncertainties in emission estimates and implications for mitigation priorities;
- To contribute to the development of compliance mechanisms and international climate negotiations;
- To assess the economic, social, and environmental effects and to quantify the benefits of improved Earth systems data;
- To investigate global impacts of forest sector and land use development in emerging economies and the impacts of globalization; and
- To identify efficient indicators for measuring governance and evaluate the relevance, efficiency, and effectiveness of ongoing international forest governance initiatives.

The FOR Model Cluster and Methods

FOR's objective is to understand the interactions between the Earth and human systems through a systems approach. Much of the analytical work is based on a cluster of existing models or models under development within the Program (see *Figure 2*). The integrated research focus clearly goes beyond the sector borders, as exemplified in the following typical FOR research topics:

- FOR regularly makes considerable contributions to the debate on tropical deforestation, one of the major sources of carbon emissions, and its social drivers, by delivering data and concepts for methodology development and implementation. For example, FOR's work on reduction of emissions from deforestation and degradation (REDD) is helping to inform the policy process of the United Nations Framework Convention on Climate Change (UNFCCC).
- FOR is coordinating the work of 17 highly recognized, multidisciplinary science partners in the European Commission–funded CC-TAME project. CC-TAME aims to: 1) integrate modeling approaches, policy assessment, and data sources into a framework, that can be used to quantify, understand, predict, and evaluate the impact of policies on land use; and 2) find effective and efficient mitigation and adaptation strategies to increase the adaptive capacity of ecosystems and decrease the emissions from land use.
- FOR tools, such as FORMICA and OSKAR, are helping to assess the impact of forest management options on the forest sector GHG budget. FORMICA calculates carbon pool trajectories under current and changing forest management in existing forests at a regional scale. OSKAR estimates biomass, dead wood, harvest yields, and costs for different forestry scenarios (thinning, species, climate change) at plot level to regional scale.

Integration

A key focus of the FOR Program is on efforts to identify and model linkages between systems. Multi-scale, synchronized,

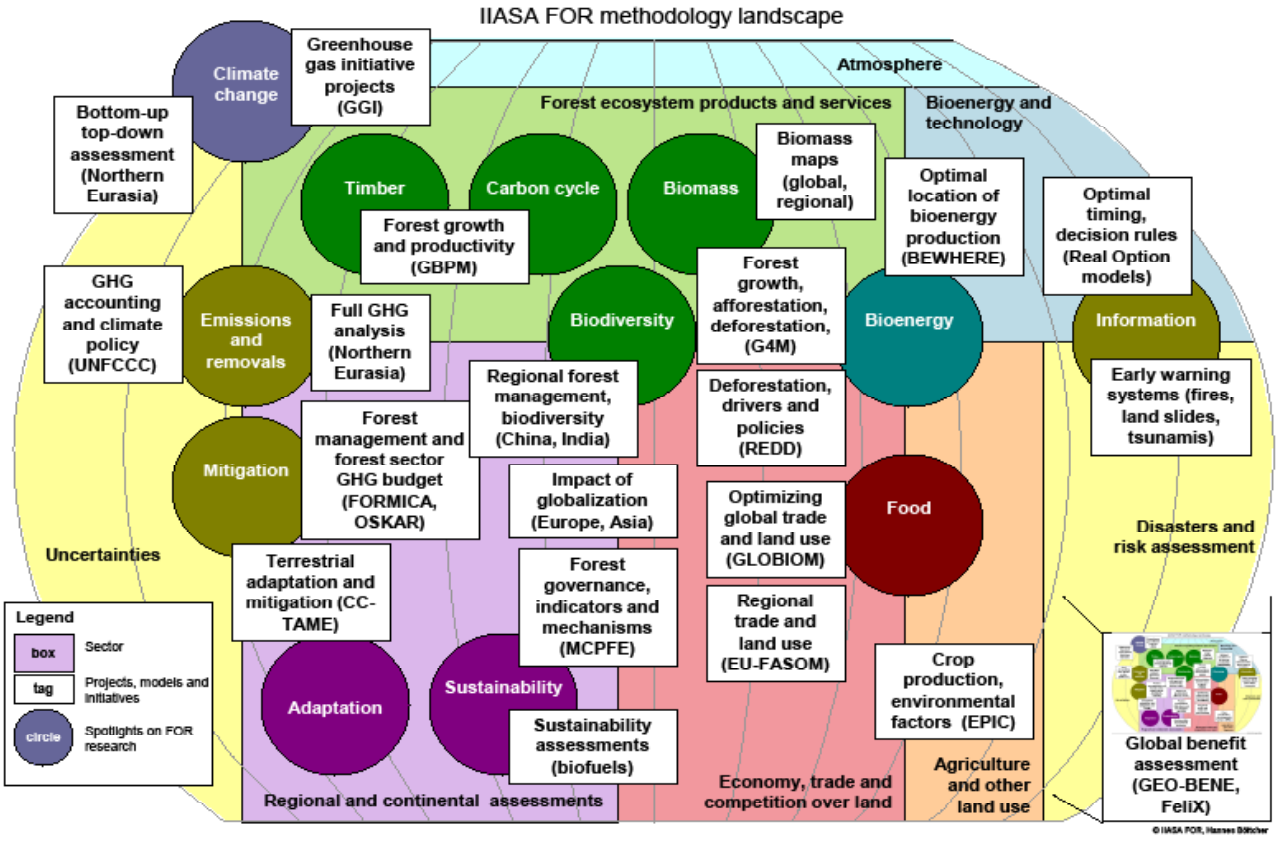


Figure 2. The FOR methodology landscape. The landscape is built on the various sectors (background colored areas) that FOR research links to. For an integrated view these must go beyond the forestry sector itself. Circles represent spotlights on FOR research on key challenges that these sectors are facing. The content of FOR research—models, projects, initiatives and data sets—is displayed in the tags.

and harmonized research is a key FOR methodology, and is applied in different dimensions, through:

- Considering forests as having an indissoluble interconnection with the outside world, leading to the paradigm of integrated land use management:
- Combining solid science with practicality of the results and bringing them to policymakers: and
- Implementation based on a "policy-data–model fusion" concept.

FOR methodology combines geographically explicit biophysical models with economic modeling, covering all land use types and thus allowing for fully integrated analysis of competitive interactions between different land uses and land use change types. Combining the different models allows for geographic explicit analysis of policies in a global context.

The various levels of integration of FOR research are demonstrated by several research projects with which FOR was involved in 2008:

Progress in 2008

Highlights—Scientific Achievements at a Glance

Top 10

- FOR organized a side event on REDD at the Forest Day during the 14th Conference of Parties (COP 14) to the UNFCCC, presented at the IIASA side event on LULUCF-MAC curves and contributed to the side event of the EDF (Environmental Defense Fund, USA).
- A FOR expert group was commissioned as one of thirteen international research groups to contribute to the "Eliasch Review," a comprehensive analysis of international financing REDD, led by the UK Office of Climate Change.
- A FOR team found that the top five countries by potential of carbon sequestration and cost competitiveness are Brazil, Zaire, Indonesia, Bolivia, and Tanzania. Brazil has the largest potential—3.4 Gt C at a cost efficient carbon price of 25$•tC-1.
- A FOR publication in the PNAS Journal on "Global cost estimates of reducing carbon emissions through avoided deforestation" received wide acclaim. The study indicates high potential for emission reductions through avoided deforestation at comparatively low costs.
- FOR created and published a global forest biomass map which can be used to estimate the amount of released carbon through deforestation activities.
- FOR's reassessment of global fossil fuel emissions, including their uncertainty, indicates that the full uncertainty of the mean global fossil fuel emissions for 2000–2005 is not 4 percent—as reported by the Intergovernmental Panel on Climate Change (IPCC) in 2007—but ranges between about 5 and 11 percent (68 percent CI).
- FOR's scenario analysis for China's paper consumption shows that increased income by households, as well as urbanization, will strongly affect paper consumption, which is expected to increase by 32 to 57 percent by 2015 and cause a substantial environmental footprint.
- Together with the Technology Information Forecasting and Assessment Council (TIFAC), the Indian NMO, FOR published in *The International Forestry Review,* an integrated assessment of the Indian forest sector demonstrating that the sector must overcome significant constraints in order to contribute to the development of Indian society.
- FOR carried out substantial dissemination of its research with respect to ongoing analyses of globalization on the forest sector.
- FOR carried out substantial analysis and related dissemination of research on the land use conflict between conventional forestry, bioenergy production, and food production.

Policy Impacts

The Eliasch Review

FOR was one of 13 international research bodies to contribute to the prestigious "Eliasch Review" in 2008 with an analysis of its model clusters.

UNFCCC

FOR continued to contribute to the UNFCCC negotiations through the organization of side events relating to the mitigation potential of forest related options. Forestry Program researchers presented their findings on Reducing Emissions from Deforestation and Ecosystem Degradation (REDD) at the UNFCCC Climate Change Talks at an IIASA side event in Accra, Ghana. It also participated at COP 14 in Poznan, Poland, in December 2008, at which FOR researchers proposed a new international body and method to cut deforestation greenhouse gases and presented a methodology to compare mitigation potentials and costs in Annex I countries in 2020.

Indian Forest Sector

FOR participated in and facilitated the publication of a Special Issue of the *International Forestry Review*, edited by Sten Nilsson, which aimed at providing Indian policymakers with a demonstration of the many constraints to development posed by this sector. The forest sector is a vital resource for the country, needing prompt and purposeful actions by policymakers if it is to be developed in a sustainable fashion.

Scientific Achievements in Core Research

In 2008 FOR research involved activities in all three themes illustrated in *Figure 1*.

1. GHG Cycling and Terrestrial Ecosystems

The aim of the theme is: 1) to devise tools, strategies, and policy-relevant information to support mitigation and adaptation strategies with respect to climate change and the terrestrial biosphere; and 2) to assess how the forest sector can contrib-

ute to the stabilization of greenhouse gas concentrations in the atmosphere.

The theme is divided into three projects: 1) Global Terrestrial GHG Management; 2) Full GHG Analysis of Northern Eurasia's Terrestrial Biota; and 3) Constraining and Handling Uncertainties of GHG Fluxes.

The objectives of **Global Terrestrial GHG Management** are to: 1) identify and quantify suitable measures of intervention in terrestrial GHG cycles in a consistent manner within forestry and agriculture; and 2) relate these to the energy and industrial sectors.

In 2008 FOR, in this project:

- Examined how contributions to forest biomass carbon stock changes of past (pre-1990) disturbances and harvest can be differentiated from recent (post-1990) changes in forest management in present and future observable carbon dynamics in managed forest ecosystems.
- Developed one of the first consistent global spatial databases at half-degree resolution containing forest growing stock, biomass, and carbon stock values.
- Analyzed the potential contribution of avoided deforestation (AD) activities to reducing GHG emissions.
- Studied the impact of further biofuel development on food prices and food security in sub-Saharan Africa, where undernourished people currently represent about 32 percent of the total population.
- Carried out research to optimize the supply chain of the biofuel industry in Austria based on cellulosic biomass, by particularly considering the waste products from the wood processing industry.
- Studied second-generation biofuel for Eastern Europe from woody biomass, currently under consideration as a wood gasifier for methanol production, by applying FOR's BEWHERE Model.
- Used an integrated approach and incorporated different types of information from several sources, including remote sensing, to identify regions, or hotspots, of future food insecurity, comparing the 1990s with 2030.

The objectives of the **Full GHG Analysis of Northern Eurasia's Terrestrial Biota** are: 1) to contribute to a better understanding of the dynamics of the cycling of terrestrial CO_2 and non-CO_2 gases, their interaction with the atmosphere, and the possibilities for contributing to stabilized concentrations in the atmosphere; and 2) to precisely quantify—by means of verified full greenhouse gas accounting (FGGA)—the mitigation potential and impacts of natural ecosystems on major global biogeochemical cycles at the continental/national level under threats from climate change and disturbance across Northern Eurasia.

In 2008 FOR, in this project:

- Demonstrated that dramatic changes are occurring and will occur in high latitudes, which will influence the emissions of GHGs; for example, thawing of the permafrost will accelerate emissions and climate change. As a result, there is a high probability of dramatic increases of natural disturbances, such as fire and insect outbreaks in forests in this region, causing GHG emissions to substantially exceed the overall target of the Kyoto Protocol.
- Developed a systems approach to assessing FGGA uncertainties, based on a new methodology that fuses multi-sensor remote sensing concept with diverse on-ground information resulted in development of hybrid land cover. This provides cost-effective ways of providing FGGA of terrestrial ecosystems at levels of uncertainties that would be satisfactory for policymaking.
- In collaboration with American colleagues, applied a new model (LANDIS II) for studying future trajectories of boreal forests under climate change and adaptive forest management in Siberia as a crucial management tool for professionals and policymakers needing to address the complexities of sustainable resource use.
- Developed a multitude of diverse models for Northern Eurasian forests that are important for the transition to sustainable forest management; they are now used by the Russian Federal Forest Service

The objectives of the project, **Constraining and Handling Uncertainties of GHG Fluxes**, is to constrain uncertainties of GHG fluxes to and from the atmosphere and to contribute to a prudent handling of uncertainties in international climate negotiations, including the Kyoto Protocol and its successors. The project adds an additional dimension—uncertainty—to the IPCC perspective, which widens the foundation on which to base economic and political decisions.

The challenges of this project are:

- To assess relevant uncertainties of the climate process drivers system (the emissions) and try to constrain them;
- To formulate relevant mitigation efforts/priorities, taking the uncertainties into account;
- To contribute to the development of relevant compliance mechanisms and contribute to future international climate agreements by taking uncertainties into account.

In 2008 FOR, in this project, worked along two tracks, expected to merge in the future:

- Track I addresses the need to close the gap between bottom-up and top-down accounting of net atmospheric carbon (and other GHG) emissions. Scientists are expected to overcome this accounting gap at the scale of continents in the years ahead and even be able to downscale verified (dual-constrained) emissions at the scale of larger countries or groups of smaller countries.
- Track II analyzes *emission changes* specifically under the Kyoto Protocol to the UNFCCC, under which inventory uncertainty is monitored, but not regulated. Once the reference framework under Track I is available, it will enable scientists to instantaneously correct any politically driven (mis)accounting reported on a bottom-up, annual basis under the Kyoto Protocol

2. Global Impacts of Forest Sector and Land Use Development in Emerging Economies

The aim of this theme is to gain a better understanding of the impacts of emerging economies on the global forest sector, especially in China and India, and how these developments

will influence the global forest sector. Work is also being carried out on total global forest sector development per se to put the development of the Chinese and Indian forest sectors into perspective.

The key challenges of this theme are to:

- Understand the development paths of forest resources and forest sectors in key emerging economies;
- Interpret these developments into overall global forest sector developments; and
- Identify the implications and policies of global forest sector development.

In 2008 outcomes within this project were as follows:

- Both 2007 and 2008 saw major efforts by FOR to get new inventory work under way in the China forestry sector; this has undergone explosive growth, causing structural changes in the global forest sector as well as strong environmental and social footprints worldwide. This work, which has now secured Chinese funding, will start in 2009.
- During the last couple of years, the FOR Program has worked on the linkage between demographic development and the forest sector, organizing a workshop and submitting a number of papers on urbanization work in 2008 to a Special Issue of *Population and Environment*.
- In 2007 and 2008 FOR began working with TIFAC, the Indian NMO, on an assessment of the Indian forest sector in broad terms. Workshops were conducted and over 25 Indian experts were commissioned to feature the status of different aspects of the Indian forest sector. The work was published in a special Issue of *The International Forestry Review* in 2008.
- Dissemination of the results of the work on the globalization of the forest sector, carried out in 2007, continued with a number of invited presentations at high profile events in Austria, Germany, and Portugal, as well as at the annual meetings of the Advisory Group on Forestry and Cork, the Forest-Based Sector Technology Platform, and the Municipal Conference for the Protection of Forests (MCPFE) inaugural session.
- With the globalization process having resulted in dramatically increased consumption of bioenergy, food, and forest fibers, leading to increased competition for land, FOR carried out a detailed case study on the sustainable use of sugar cane for ethanol production in Brazil.
- FOR presented work on global cost estimates of reducing carbon emissions through avoided deforestation.
- FOR started a project with partners to: 1) improve understanding of the driving forces for land use leading to deforestation; and 2) to assess the costs of reducing deforestation.
- FOR started interaction with the World Bank on a case study on the Congo Basin countries with respect to REDD. This work was presented in 2008 at a side event at the UNFCCC Climate Change talks in Accra and at the IIASA–FOR side event at the Forest Day of UNFCCC COP 14 in Poznan. To improve understanding of how deforestation develops, FOR has developed a Global Land Cover Validation System to carry out land cover validation and land use change over time.
- The FOR Program began efforts to help bridge the two Koreas through an integrated large-scale international reforestation program involving South Korean experts, North Korean partners, and international experts. A workshop is scheduled for spring 2009 in Seoul.
- As mentioned above, FOR researchers developed a real options model, which provides an option: 1) to invest in less carbon-intensive energy technology; and 2) to purchase credits on REDD. Either option can be exercised or not, depending on the future evolution of CO_2 prices.

3. International Governance of Forests

The objective of this theme is to assess the relevance and effectiveness of international arrangements on forests, the globalization of the forest sector, and to bring the research results achieved by FOR to the international policy and governance arena. Outcomes in 2008 were as follows:

- A FOR review of the degree to which these international governmental initiatives on forests have been transposed and applied at regional and local levels found major gaps between the international and national policy concepts developed and their implementation at regional and local levels.
- In cooperation with the Timber Committee of the Forestry Department of the UNECE/Food and Agriculture Organization (FAO), and the University of Natural Resources and Applied Life Sciences, Vienna, FOR developed governance indicators and database for the EU countries that, in 2009, will encompass all countries that are part of the MCPFE.
- FOR used scenario modeling to assess the costs of reducing global deforestation and explored a range of mechanisms to combat deforestation. The results of this research were presented at a side event at COP 14 in Poznan.
- FOR was awarded a grant to review the international governance process of the MCPFE in Europe, with respect to relevance, efficiency and effectiveness with its work. The MCPFE has existed since 1990 without evaluation.

Publications and Web Site

FOR published a total of **74** publications, of which 45 were in the category of refereed journal articles, books, and book journals.

FOR's Web site is an important tool for the dissemination of information and results of FOR work. The statistics are illustrated in Table 1.

Table 1: Statistics for FOR's Web site.

	2006	**2007**	**2008**
Hits	265,000	300,000	334,000
Band Width (GB)	28	45	67

In 2008, there were fewer visitors compared to 2007, but the number of pages visited was substantially greater. FOR has taken action to develop a more efficient Web presence in 2009.

Awards

- Ewald Rametsteiner was appointed Guest Professor, International Forest Policy at the University of Belgrade.
- Anatoly Shvidenko was awarded the Honorary Medal of Russian Forestry by the Russian Union of Foresters.
- Sten Nilsson was elected as Member of the Advisory Board of the World Resources Forum, Davos.
- Sten Nilsson was elected as Rights and Resources Fellow of the Rights and Resources Initiative, Washington, DC.
- Sten Nilsson was elected as Foreign Member of the Lithuanian Academy of Sciences.
- Florian Kraxner has been appointed by the Austrian Federal Ministry of Agriculture, Forestry, Environment, and Water Management as official Austrian Delegate to the UNECE/FAO Team of Specialists on Forest Products Markets and Marketing.

Editorships

- Sten Nilsson is on the editorial board of *Carbon Balance and Management*.
- Michael Obersteiner is on the editoral board of *Carbon Balance and Management*.
- Anatoly Shvidenko is on the editorial board of *Forest Inventory and Planning*, the *Journal of Applied Earth Observation and Geoinformation*, the *Journal of Siberian Federal University (Engineering and Technologies)*, and on the editorial advisory board of *Mitigation and Adaptation Strategies for Global Change*, as well as a Member of the Science Advisory Committee of the *Eurasian Journal of Forest Research*.
- Gui-Ying Cao is on the editorial board of *African and Asian Studies*.
- Ewald Ramesteiner is on the editorial board of *Forestry: An International Journal of Forest Research*.
- Steffen Fritz is on the editorial advisory board of the *Open Geography Journal*.

Selected Invited Presentations

- Ian McCallum was invited to give a keynote address on "Scientific milestones and future collaboration options between Europe and China" organized by the European Commission in Helsinki, 12–14 October.
- Steffen Fritz was invited to give a keynote address on "Availability of cropland for agriculture, citizen science, and future potential hunger hotspots in sub-Saharan Africa" organized by United Nations/Kenya/European Space Agency Workshop on "Integrated Space Technology Applications for Monitoring Climate Change Impact on Agricultural Development and Food Security" in Nairobi, 1–5 December.
- Michael Obersteiner and Steffen Fritz gave a IIASA side event on "REDD for eocysystem values—REDD monitoring system and costs" at the UNFCCC Climate Change Talks in Accra, 7–10 August.
- Michael Obersteiner was invited to give a keynote address on "Biofuel: Grand issues in sustainability" organized by OECD/EEA in Venice, 19–20 May.
- Petr Havilk, Steffen Fritz, Michael Obersteiner, and Georg Kindermann gave a keynote address on "Food security and biofuels in sub-Saharan Africa" at the International Conference on Food Security and Environmental Change, Oxford, 2–4 April.
- Petr Havlik and Michael Obersteiner were invited to give a keynote address on "GLOBIOM – Global biomass optimization model: Biofuels and land use change" at the Biofuels Expert Meeting on Biofuels and Land Use Change, Sao Paulo, 20–21 November.
- Florian Kraxner was invited to give a keynote address on "Food, fiber and fuel" at the IEA Executive Committee Meeting in Oslo, 13–16 May.
- Michael Obersteiner, Ian McCallum, and Hannes Böttcher participated in a side event at COP 14 with a presentation on "Comparability of mitigation efforts in Annex I countries," Poznan, 2 December.

- Michael Obersteiner, Hannes Böttcher, Petr Havlik, and Florian Kraxner gave a side event at the COP 14 Forest Day on "REDD Hot Air," Poznan, 6 December.
- Michael Obersteiner was invited to give a keynote presentation on "Biomass and climate policy" at the AAAS Annual Meeting in Boston, February.
- Hannes Böttcher was invited by the UNECE Timber Section to give a keynote on "Wood products and biofuels," Geneva, 9–10 September.
- Steffen Fritz gave an invited keynote address on "Interaction between the atmosphere and land cover" at the UN/Austria/ ESA Symposium on Space Solutions for Monitoring the Interaction between the Atmosphere and the Land Cover," Graz, 8–10 September.
- Steffen Fritz was invited to give a keynote address on "Uncertainties in global land cover products: Impacts derived from the global biomass optimization model by GOFC-GOLD," Jena, 12–18 October.
- Steffen Fritz was invited to give a keynote address on "A benefit assessment of GEOSS with respect to the social benefit areas, biodiversity and ecosystems" organized by GEO, Foz do Iguacu, Brazil, 3–7 November.
- Sten Nilsson was invited to give a keynote address, "Political frameworks for successful use of bioenergy" at a conference organized by Nordic Council and the EC, Stockholm, 1–4 March.
- Sten Nilsson gave a presentation on the FOR Program at the KOSEF/IIASA Consultations, Seoul, 26–30 April.
- Sten Nilsson was invited to give a keynote address to The Marcus Wallenberg Prize Committee on "Globalization of the forest sector," Uppsala, 3–5 April.
- Sten Nilsson was invited to give a keynote address on "Mountain forests in a changing world" at the conference with the same title, Vienna, 2 April.
- Sten Nilsson was invited to give the keynote address on the Estonian Forestry Vision Conference organized by the Estonian Government on "Globalization of the forest sector," Tartu, 17–18 April.
- Sten Nilsson was invited to give the keynote address at the EU Forest Technology Platform Annual Meeting on "Globalization of the forest sector," Kranjska Gora, Slovenia, 19–21 May.
- Sten Nilsson, Michael Obersteiner and Ewald Rametsteiner were invited to give keynote presentations at the Tällberg Forum in the Forestry Session, Tällberg, Sweden, 23–29 June.
- During his term as Acting Director in 2008, Sten Nilsson gave 15 additional keynote addresses on different topics.

Land Use Change and Agriculture Program

Günther Fischer
fisher@iiasa.ac.at

Objectives

The strategic goal of the Land Use Change and Agriculture (LUC) Program is to support policymakers in developing realistic, rational, science-based strategies at the national, regional, and global level for the production of food, animal feed, fiber, bioenergy, and other services that achieve long-term sustainability of land and water resources, while promoting rural development.

To achieve this goal, the LUC Program aims to advance applied science with a focus on the following strategic research objectives:

- Development of new and improved tools and databases to provide a spatially detailed understanding of alternative land and rural development options and strategies against a background of global change;
- Analysis of synergies and trade-offs of alternative uses of agro-resources (land, water, technology) for producing food and energy, while preserving environmental quality;
- Identification of hotspots of significant environmental and rural social risks and clarification of their relation to global change; and
- Verification of methodologies and tools needed to improve global scenarios and links with region-specific conditions, issues, and policy options in applications for regional/national case studies.

Three areas of research, outlined below, are identified for the period 2006–2010. These cover key issues of importance for understanding the interactions between society, land use, agriculture, and climate over the coming decades.

Research Areas

The first area provides a common thread for the Program's global research through a "Food and Agriculture to 2100" project that unifies the themes of climate and anthropogenic impacts on soil and water resources, adaptation and mitigation strategies, and rural development. The second area analyzes subsets of these issues in regional case studies in Europe, China, South Asia, sub-Saharan Africa, and Latin America. The third area includes activities aimed at developing new methodologies to derive spatially explicit data and provide better integration of socioeconomic and biophysical analyses.

Global level research:

- Food and agriculture to 2100;
- Climate change, impacts, mitigation, and adaptation;
- Water and agriculture; and
- Biofuel production, land use competition, and food security.

Policy support for sustainable development of regional agricultural and rural sectors:

- Food security and the Millennium Development Goals;
- Agriculture and rural development ;
- Environmental sustainability and agriculture; and
- Biofuel development strategies.

Methodology development:

- Sequential rebalancing methods for spatial allocation and downscaling;
- Framework for spatial ecological–economic analysis; and
- Integration of mainstream economic indicators with sustainable development objectives.

Scientific Achievements

In 2008 LUC scientific activities were carried out in all three thematic areas listed above.

Agriculture in the 21st Century

IIASA's integrated food system modeling framework comprises a global spatial agro-ecological zone (AEZ) model and a regionalized general equilibrium model of the world food system (WFS). The two complementary models form the basis of scenario evaluation and policy analysis of food and agriculture in the 21st century at the national, regional, and global levels. Of particular interest were liquid biofuels for transport, which have been strongly acclaimed and heavily criticized in recent months for their potential to benefit society as well as the considerable risks their expansion may pose to food security and environmental sustainability.

Food Security and Biofuel Production

The recent expansion and growth of bioenergy markets as a result of new energy and environment policies enacted over the past decade in most developed countries and in several developing countries, is reshaping the role of agriculture. Most significant is the sector's increasing role as a provider of feedstock for the production of liquid biofuels for transport. While modern bioenergy holds promise for the creation of income and employment in the rural sector, the speed of expansion has generated increasing competition for natural resources. Competition for land becomes an issue especially when important food and feed crops, including maize, wheat, and soybean, are redirected toward the production of biofuels. In 2008 several activities in LUC focused attention on this area of research.

The objective of a global LUC study in 2008, commissioned by the Organization of the Petroleum Exporting Countries (OPEC) Fund for International Development, was to scientifically assess the implications of an accelerated increase in biofuels production. Sustainability issues, competition for land use, food security, and greenhouse gas savings were among the aspects that the study addressed.

The study provides an overview of the current status and trends in biofuel development and summarizes the biofuel policies of all major players—Brazil, China, the European Union, India, and the United States. It presents an assessment of the potential of the main agricultural crops used as major biofuel feedstocks for ethanol and biodiesel production (see *Figure 1*

below showing an example of *Jatropha curcas*, an extension of the Global AEZ capabilities implemented in the context of the study).

LUC's World Food System model was updated and extended to include biofuel feedstock supply and co-products (e.g., the potentially huge amounts of livestock feeds produced when crushing oilseeds and converting starchy crops to bioethanol). A number of scenarios covering a wide range of possible future demand for transport biofuels for the period 2000 to 2030 were assessed in terms of their impacts on food availability, prices, trade, and worldwide use of agricultural inputs (notably fertilizer) and land. Scenario inputs included: the International Energy Agency's (IEA) recently published World Energy Outlook 2008; mandates and indicative biofuel targets announced by several countries; and various sensitivity analyses and expert opinions to account for the uncertainty of the availability of second-generation biofuel conversion technologies.

Lessons and conclusions drawn from the quantitative scenario analysis provide guidance toward policies for establishing a socially beneficial and environmentally acceptable way forward with biofuel development and deployment. Among the robust policy-relevant research findings are the following: (i) Implementing ambitious global biofuel targets for 2020 based on current first-generation technologies will put food security in developing countries at risk and will not achieve any significant reduction of greenhouse gas emissions; (ii) Meeting ambitious global biofuel targets for 2030 in a sustainable manner requires rapid deployment of second-generation feedstocks and conversion technologies; (iii) Biofuel policies require a global scope and international development partnerships to avoid pitfalls; and (iv) Biofuels are not all equally "good" or "bad," and knowledge-based policymaking is required.

The study identified several policy support measures critical for achieving sustainable expansion of biofuels: Renewed efforts to enhance agricultural productivity; protecting the poor against impacts of rising agricultural prices; empowering poor rural agricultural communities; promoting second-generation biofuel technologies; establishing sustainability criteria and best land use practices; and, fostering equitable partnerships with local communities. Even then, liquid transport biofuels are only one among many sources of renewable energy and their efficiency and societal value needs to be assessed vis-à-vis other current and future energy options within comprehensive national and global energy stategies.

Renewable Fuels for a Sustainable Europe (REFUEL)

The European Union (EU)–commissioned REFUEL Project presented its final results—a "2030 roadmap"—and policy conclusions to decision makers and stakeholders in Brussels in March 2008. The two-year project, involved seven renowned European partners.

As a follow-up to this successful project the REFUEL consortium members compiled scientific papers for a 2009 Special issue of *Biomass & Bioenergy*. LUC contributed two peer-reviewed articles. The first paper presents a spatially explicit biofuel feedstock suitability and productivity assessment for Europe. Both arable land and grassland have been considered in a broad range of biofuel feedstock production options. The assessment based on IIASA's agro-ecological zones modeling framework distinguished five main groups of feedstocks covering a wide range of agronomic conditions and energy production pathways, namely: woody ligno-cellulosic plants, herbaceous ligno-cellulosic plants, oil crops, starch crops, and sugar crops. The productivity assessment was carried for a uniform 1 km^2 pan-European land resources database by matching climate characteristics with plant requirements and calculating annual biomass increments or

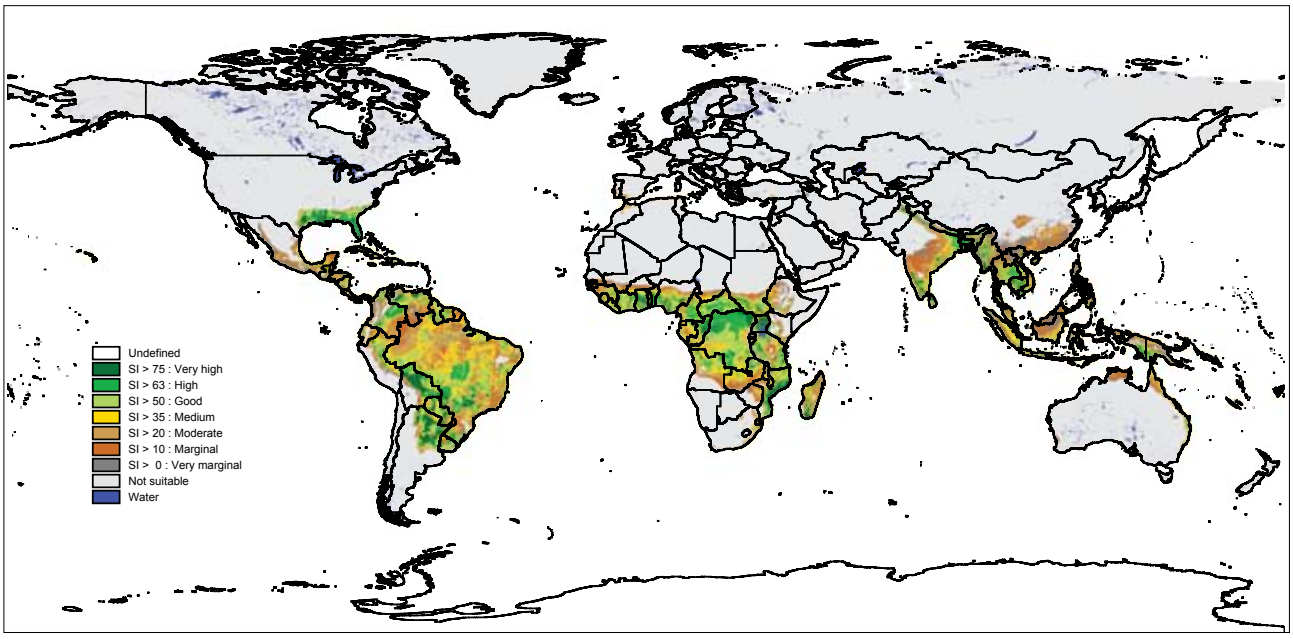


Figure 1. Global suitability for rain-fed *Jatropha curcas*

yields, including consideration of the soil and terrain characteristics of each grid-cell. Estimated agronomical attainable yields, both in terms of biomass (kg ha^{-1}), as well as biofuel energy equivalent (GJ ha^{-1}), were mapped and tabulated by agriculture and pasture land cover classes as derived from the CORINE land cover database. Results have been further aggregated by sub-national administrative units.

A second paper describes a set of land use scenarios. A "food first" paradigm was applied in the REFUEL calculations of land potentially available in Europe for biofuel feedstock production, which stipulated that this land be available without putting at risk food supply or nature conservation. Three scenarios were formulated: (i) A *Base* scenario that reflects expected developments under current policy settings and respects current trends in nature conservation and ecological sustainable farming practices. It assumes moderate overall yield increases; (ii) an *Environment-oriented* scenario that puts additional emphasis on sustainable farming practices and biodiversity; and (iii) an *Energy-oriented* scenario, that considers more drastic land use conversions, including the use of surplus pasture land.

Effective and Low-disturbing Biofuel Policies (ELOBIO): This 3-year project, which started at the end of 2007 and will run to the end of 2010, seeks to identify integrated policy measures that are suitable for the promotion of biofuels while at the same time avoiding or minimizing negative effects on other policy goals and markets. LUC's role in ELOBIO is to model the impacts of increased demand for biofuel feedstocks on food and feed commodity markets and to assess the effects of different policies and measures aiming to reduce this disturbance. In 2008 ELOBIO analyzed the turbulent commodity markets and held a stakeholder workshop in Brussels to define a set of policy measures to be represented in the ELOBIO scenario analysis. ELOBIO research and recommendations are serving the Intelligent Energy Executive Agency of the European Commission.

Water and Agriculture

Water is a key driver of agricultural production. The area under irrigation has expanded to over 270 million ha worldwide, about 18 percent of total cultivated land. Agriculture is the largest user of water of all human activities: irrigation water withdrawals represent 70 percent of the total anthropogenic use of renewable water resources. This has brought agriculture into competition with other water users and has impacted negatively on the environment. The research in this thematic cluster undertakes a comprehensive, spatially detailed quantification of water needs for agriculture based on the integrated ecological–economic evaluation of food system changes against a background of future global change.

Water and Global Change (WATCH): This four-year integrated project, which is being funded under the European Commission's 6th Framework Programme, brings together more than 25 institutions in the hydrological, water resources, and climate communities to analyze, quantify, and predict the components of the current and future states of the global water cycles and related water resources, to evaluate their uncertainties, and to clarify the overall vulnerability of global water resources related to the main societal and economic sectors. LUC's task is to provide global spatial data on key components of the water cycle from 1900 to 2100 regarding agricultural, industrial, and domestic uses. This involved scenario projections of agriculture development and land use change as well as development and application of modeling techniques and methodologies for scaling and analyzing the data.

As part of WATCH, LUC was invited by the UK Research Council and the Institute of Atmospheric Physics of the Chinese Academy of Sciences to give a presentation at the China–UK Climate Change and Global Water Cycle workshop held in Beijing in November 2008. LUC delivered various digital spatial datasets of present and simulated future land use to WATCH, as well as delivering the harmonized world soil database (HWSD) to the consortium. At the WATCH general assembly held in Bratislava in November 2008, LUC organized a special session on WATCH work block 2: past, present, and future population, land and water use. At this session, several IIASA scientists presented research and assumptions underlying the respective scenario elements that IIASA is contributing to WATCH.

Water Scenarios for Europe and for Neighboring States (SCENES): SCENES is a 4-year EU Integrated Project with 23 partner institutions that includes stakeholders in the development and analysis of a set of comprehensive scenarios of Europe's freshwater futures up to 2025. The involvement of LUC within SCENES centers around driving forces.

To assist the SCENES Pan-European Panel (PEP) at its February 2008 meeting, a review of data on past developments and trends was performed for: population; education; economic growth; energy production by type; energy consumption and intensity; land use (urban areas, cropland, forest, pasture); agro-ecology (length of growing period, yields and yield potential); agriculture emissions (dairy cattle, other cattle, pigs, fertilizer use); demand for and production of forestry products; water use by sector; and irrigation water withdrawals. The data were presented to the PEP, and examples of future scenario projections developed and shown. For the PEP meeting in November 2008, additional analysis was performed on population, GDP, and land use. Various scenario projections were compared by IIASA experts to guide the PEP discussion.

Land Resources and Agro-ecological Zoning

The Food and Agriculture Organization of the United Nations (FAO), with the collaboration of IIASA, has developed a major spatial analysis system that enables rational land-use planning on the basis of an inventory of land resources and evaluation of biophysical limitations and production potentials of land. This is referred to as the agro-ecological zones (AEZ) methodology. The AEZ methodology follows an environmental approach; it provides a standardized framework for the characterization of climate, soil, and terrain conditions for analyzing synergies and trade-offs of alternative uses of agro-resources (land, water, technology) for producing food and energy while preserving environmental quality.

Global Agro-ecological Zones Assessment (GAEZ 2008): As part of the GAEZ 2008 update and expansion, LUC has implemented and applied new parametric soil evaluation procedures, which make use of the soil attributes stored in the harmonized world soil database (HWSD) and replace previous expert-based soil unit ratings. In the context of LUC's applied research projects and broadening the AEZ application, several additional crops and land utilization types were implemented such as *Jatropha*, coconut, tea, and various vegetables.

In 2008 two new assessment components were implemented for GAEZ. First, a methodology was developed to assess within the AEZ framework the impacts of surface ozone (O_3), a potent phytotoxic air pollutant that can severely reduce the productivity of important agricultural crops. We then performed an integrated modeling study, considering biophysical and crop management factors, to quantify the potential ozone impacts and agronomic adaptation options on the production of four key food and feed crops (wheat, maize, rice, and soybean) for emission scenarios in 2000 and 2030. Second, LUC developed and implemented a suitable methodology to assess within AEZ the possible impacts of extreme temperature events on crop yields. For the purpose of analysis, we used daily temperature data simulated on a spatial grid for the historical period 1971 to 2000 and for years 2071 to 2100 (these data were kindly provided by the Japanese National Institute for Environmental Studies).

Harmonized World Soil Database (HWSD): The lack of globally systematic soil data has added to the uncertainties of predicting the potential for, and constraints to, food and fiber production and of estimating the capacity of soils to hold carbon and to act as a carbon sink. Recognizing the urgent need for improved soil information worldwide, the FAO and LUC spearheaded a powerful consortium of organizations dealing with applied soil science. LUC took the initiative of combining the recently collected vast volumes of regional and national updates of soil information with the information already contained within the 1:5,000,000 scale FAO–UNESCO Digital Soil Map of the World to create a new comprehensive Harmonized World Soil Database. The HWSD includes a 30 arc-second raster with about 30,000 different soil mapping units, which are linked to harmonized soil property data. The use of a standardized structure allows for the linkage of the attribute data with the raster map to display or query the composition in terms of soil units and the characterization of a dozen selected soil parameters.

Version 1.0 of the HWSD was jointly released by IIASA and FAO in July 2008. The HWSD database can also be downloaded at: www.iiasa.ac.at/Research/LUC/luc07/External-World-soil-database. It is also available on DVD from FAO. The HWSD is of immediate use in the context of the Climate Change Convention and the Kyoto Protocol for soil carbon measurements and for the FAO/IIASA GAEZ 2008 study for which HWSD was developed in the first place.

Policy Support for Sustainable Development of Agriculture and Rural Sectors

In support of and complementing the global studies, LUC has been conducting or initiating a number of regional projects, for example: in Ukraine on agriculture and rural transformation in transition economies; in Europe on land use issues related to sustainability and biofuel production; and in China on water scarcity and agro-environmental impacts in the context of rapid growth, globalization, and global change. These projects consider a time horizon of 25 to 50 years and are carried out at the regional/national scales in close collaboration with local research partners. The studies address critical policy issues of land stewardship, based on spatially detailed assessments of policy alternatives with specific consideration of social development in rural areas and implications for the resource base and ecosystems.

China Agricultural Transition: Social and Environmental Impacts (CATSEI): This EU-funded project, implemented by six prominent European, Chinese and USA-based partners, investigates the impact of China's rapid economic transition on its agricultural economy with special reference to the consequences of trade liberalization and to changing trade flows. The research focuses on three themes: trade, social conditions, and environment.

LUC carries out the agronomic and environmental assessment in CATSEI WP 4. A state-of-the-art land resources database for China (using a 1 km raster) and updated agro-ecological assessment tools are used to quantify the environmental pressures resulting from intensified livestock and horticulture production. The potential damage caused by rising ozone concentrations (see above) for 2000 and 2030 were assessed for China, and impacts of climate change were quantified. Findings on the three themes will be presented at international conferences in 2009 and will be integrated into the economic and social analysis of CATSEI. Through this, policy suggestions will be derived that account for efficiency, equity, and sustainability considerations. Throughout the project, a policy dialog and dissemination program, conducted in both China and the EU, maintains communication with policymakers.

Integrated Nitrogen Management in China (INMIC): Meeting the need for agricultural products has boosted the development of industrial input-intensive agriculture in China, characterized by high nitrogen fertilization rates and rapid introduction of industrial livestock production units.

In 2008 the data and scenario projections generated in the CATSEI project were used for a joint project with the Atmospheric Pollution and Economic Development Program under the umbrella of IIASA's Greenhouse Gas Initiative. The INMIC project developed an integrated framework for the analysis of environmental impacts related to nitrogen use and management as a function of demographic and economic drivers, available resources, and potential abatement measures. The framework in a consistent way integrates the demand-driven agricultural scenarios generated in CATSEI with simulations of the nutrients fluxes to air and water (using components of the GAINS model and the MITERRA model, respectively). Indicators of nitrogen leaching and of the release of nitrous oxide and ammonia into the environment were both calculated. This allowed us to quantify the magnitude of environmental loads for alternative development scenarios and to assess the impact of mitigation options and improved nutrient management to reduce environmental and health risks due to agriculture.

Integration of Mainstream Economic Indicators with Sustainable Development Objectives (IN-STREAM): LUC is one of eight partners in IN-STREAM, a new 3-year EU-funded collaborative research project launched in October 2008. The main goal of the project is to better integrate mainstream economic indicators with sustainable development objectives. Mainstream economic measures like GDP are still used as the main indicators of human progress, despite their many acknowledged deficiencies and the significant work undertaken on sustainability indicators and green accounting measures in the last two decades. However, there is now a renewed interest and momentum on the part of European policymakers and researchers in developing headline indicators that go beyond economics to more comprehensively assess societal progress. LUC's contribution is to first review previous modeling and statistical work that has attempted to bridge the gap between macroeconomic indicators and sustainability measures; we will then propose improved linkages of indicators in the agriculture, land use, and the food sector. Based on IN-STREAM analyses, recommendations for new indicator approaches will be proposed and strategies for implementing these approaches will be identified and developed in consultation with stakeholders.

Collaboration with NMO Institutions

Ukraine:

Institute of Economic Forecasting (IEF), National Academy of Sciences (NAS), Ukraine, Kiev: In 2008, a working meeting was held at the IEF to present the agricultural planning model developed in the CATSEI and INMIC projects and to discuss its application to the Ukrainian case study. Collaboration with former Young Scientists Summer Program participant Viktor Yarovoj from IEF resulted in a joint publication on land pricing in Ukraine. Comprehensive discussions of biofuel development and related sustainability issues took place at a policy roundtable organized by the IEF. During this meeting, keynote addresses were presented by S. Nilsson and G. Fischer.

Institute of Cybernetics (IC), NAS, Ukraine, Kiev: LUC has long been collaborating with the IC on topics related to agricultural production and sustainable land use planning under uncertainties, including recent joint publications with the IC Director ,Academician I.V. Sergienko, and Prof. Dr. P.S. Knopov, leader of the Operation Research Department. A number of working meetings were held with IC scientists to identify potential future topics for joint collaboration. LUC also participated in the International Conference on Problems of Decision Making under Uncertainties, jointly organized by the T. Shevschenko State University of Kiev, the Institute of Cybernetics, Kiev, and IIASA.

Poland:

Joint collaboration is ongoing with Integrated Modeling Environment project scientists and former YSSPs, P. Nowak and M. Romaniuk, from the Systems Research Institute of the Polish Academy of Sciences, on the development of approaches to land use planning and sustainable agricultural production under catastrophic risks. The challenging issue here is the combination of structural and financial measures and fair pricing of financial instruments.

China:

Jointly with Professor X.Y. Zheng. from the World Health Organization (WHO) Collaborating Center on Reproductive Health and Population Science, Institute of Population Research, Peking University, a proposal has been prepared reflecting interests in possible collaborative work. The goal is to study complex linkages between economic growth, changing urbanization patterns, and impacts of intensive agriculture on the environment and human health risks. Essential factors that may mitigate these risks are rising income and education levels.

India:

Currently an India–IIASA project proposal on applying the integrated AEZ-WFS methodology at state level is in preparation. The participating Indian institutions have been identified. The goal of the project is to test the methodology developed at IIASA at state level and extend it to national level study on issues of food security, land and water resource limitations, climate change, and rural livelihoods. An India–IIASA meeting was held in 2008 at the Planning Commission in New Delhi and a joint policy-oriented research project has been agreed upon, which is due to start in 2009.

Part II

Population and Society

Processes of International Negotiation Network

Ariel Macaspac Penetrante, Program Coordinator
macaspac@iiasa.ac.at

The Processes of International Negotiation (PIN) meets three to four times a year, twice at IIASA and once or twice at its yearly Roadshow venues. Most work is carried out by the PIN Steering Committee Group members on a voluntary basis, bringing IIASA a quantity (and quality) of activity that could otherwise be financially out of reach.

Strategic Goals and Objectives

The quality of the PIN Program can be measured, not only relatively, but also absolutely against its purpose, which is: to promote an improved understanding and practice of the processes of international negotiation through publications, conferences, consultations, networks, and outreach.

PIN's initial goal was to offer basic systems analysis of the state of the art of negotiation knowledge, then to identify major issues, approaches, and analyses needing serious study. These include negotiation issues related to the problem of communicating and processing advanced scientific knowledge on outstanding international issues. Several types of topics invite PIN's attention. Of particular interest are issues of multilateral negotiation, conflict escalation and prevention, and comparative methodologies. As the Program is able to publish only one book a year, this topical agenda will continue well into the future.

PIN's purpose also requires outreach work in terms of visiting institutions with an interest in developing their understanding of negotiation. PIN's visits have often been of importance in supporting the study and teaching of negotiation in institutional research and curricula. Wherever possible, PIN has involved other IIASA programs in its work and developed knowledge for their use.

PIN is currently strengthening and rejuvenating its Steering Committee. Professor Mark Anstey became a Steering Committee member in 2008. Professor William H. Donohue of Michigan State University and Professor Jacob Bercovitch of Canterbury University, New Zealand, became Associate Steering Committee members in 2008 and Professor Fen Osler Hampson from Canada in 2009. From summer 2009 on, Professor Valerie Rosoux from Belgium will join the Steering Committee. The Committee has also begun to prepare younger successors to current members who wish to retire (with honors). Possible new full and associate members are also being sought, while maintaining the Steering Committee at a manageable size.

Scientific Achievements and Policy Impact

International Conferences and Workshops

The Geneva Negotiation Day

Around 100 diplomats, researchers, and representatives from international organizations and nongovernmental organizations (NGOs), as well as interested students, participated in "Geneva Negotiation Day" on multilateral diplomacy, hosted by the Geneva Centre for Security Policy (GCSP) on 11 February 2008 and organized and presented by members of the PIN Steering Committee. Geneva is the largest United Nations duty station outside the UN headquarters in New York and a focal point for multilateral diplomacy, servicing over 8,000 meetings a year. The workshop thus provided an excellent opportunity for PIN to represent IIASA at a high-profile international event.

Among the issues emerging at the workshop was the description of negotiation as a "flow of communication" among different stakeholders. The role of scientists, it was concluded, is to identify the problems and formulate probable scenarios; decision makers can then make decisions based on the framework provided to them by the scientists.

The Warsaw Negotiation Day

The PIN Program, in collaboration with the University of Warsaw, the Austrian Foreign Ministry, and the French and U.S. embassies in Poland, hosted a conference on Negotiation on 11 December 2008 at the University of Warsaw. The conference explored the processes used by European Union nations in negotiating a range of issues, including risks, nuclear-test-ban treaties, and negotiating climate change. It provided the opportunity for local scholars to make presentations on negotiation, using case studies on Polish accession to the EU and the North Atlantic Treaty Organization.

The date of the conference in Warsaw was chosen deliberately by PIN to coincide with the 14th Conference of Parties (COP 14) to the United Nations Framework Convention on Climate Change (UNFCCC) in Poznan, Poland. The processes of negotiation can be regarded as a significant element of capacity building in regions that will need to learn how best to negotiate on climate change, either as an individual state or group of states. Representatives of the diplomatic corps, NGOs, government agencies, and universities attended the PIN conference.

"Theorists Meet Practitioners" Workshop

On 20 June 2008 PIN Steering Committee members and IIASA colleagues met for one day at IIASA with eminent practitioners with proven experience in international negotiations in particu-

lar areas. More than 50 participants including 10 ambassadors, military officials, NGO representatives, university professors, and students from all over the world attended the workshop. The project, which was organized by Professor Rudolf Avenhaus and Ambassador Franz Cede, consisted of four panels, during which theoretical concepts were presented by a theoretician and subsequently discussed by a practitioner. Formal Models, Escalation, Symmetry versus Asymmetry (in relationships between negotiating parties), and International Terrorism were the panel themes, and each panel was rounded off by a general discussion.

A more elaborate paper on this project is now planned; this will include more information on the four panel themes, with a view to submitting the final text to an international negotiations journal in 2009.

External Efforts to Promote Negotiation and Prevent Genocide in Internal Identity

Conflicts Workshop (ExIn)

The PIN summer workshop on the 2008 book project, "External Efforts to Promote Negotiation and Prevent Genocide in Internal Identity Conflicts," was held at IIASA on 21–22 June 2008. Thirteen papers were presented and discussed by more than 60 representatives of the diplomatic corps, NGOs, and academic institutions. The workshop was the first editorial meeting for the book project on this topic, which is to be funded by the Secretariat of the United Nations Special Adviser on the Prevention of Genocide, Under-Secretary-General Francis Deng. The new book project marks PIN's entry into the international policy stream at the highest level. The project organizers are Mark Anstey, Paul Meerts, and I. William Zartman, in close collaboration with Under-Secretary-General Deng.

Among the possible topics to be covered are: Indonesia (Aceh), Afghanistan, Burundi, Russia (Chechnya), Mexico (Chiapas), Congo-Brazzaville, Moldova, Georgia (Ossetia), Israel/Palestinian Territory, Philippines, Rwanda, Somalia, Sudan (South, Darfur, Beja), Tajikistan, Democratic Republic of the Congo, the work of the High Commissioner on National Minorities of the Organization for Security and Cooperation in Europe (OSCE), the European Court on Human Rights, and the Conference on Security, Stability, Development, and Cooperation in Africa.

Speakers at Caspilog 3 held in Kazakhstan in October 2008

Caspilog 3

The third session of Caspilog (The Caspian Dialog) took place on 3–4 October at the Presidential Palace No. 2, Almaty, Kazakhstan. Caspilog is an ongoing series of meetings of government, NGOs, and civil society representatives from the five littoral states of the Caspian Sea: Azerbaijan, the Islamic Republic of Iran, Kazakhstan, the Russian Federation, and Turkmenistan (in absentia), as well as other countries outside the Caspian Region, to discuss issues of common concern, other than the more contentious topics besetting the region.

The purpose of Caspilog is to foster communication and involvement among the littoral nations to create a supportive base as the eventual basis for a Caspian regime. Altogether, 80 delegates from four of the five countries attended. PIN invited international experts, mainly scientists from IIASA working on fisheries, water, air pollution, and other Caspian-related issues, to make presentations. Cooperating with the PIN Program are the Land Use Change (LUC) and Evolution and Ecology Program (EEP), programs, as well as water researchers. Speakers from the Netherlands Institute of International Affairs, Clingendael, and the International Ocean Institute also participated, as did speakers from a number of Kazakh Institutes and the United Nations Development Programme (UNDP).

Perhaps one of the most important aspects of Caspilog 3 was its symbolism, in the sense that it represented the point at which those involved in the Dialog began to take ownership of it: a very important development as, from the first Dialog, the organizers had stressed the importance of Cooperation–Partnership–Ownership.

About half the experts participating in the discussions were local, with co-organizer and sponsor, the Institute for World Economy and Politics (IWEP) inviting many of its own scientists and experts. The next Caspilog is planned for Astrakhan in 2009 in collaboration with the International Ocean Institute. CaspiLog is organized by Paul Meerts, Franz Cede, and I. William Zartman.

PIN 2008 Publications

PINPoints

PIN published two issues of *PINPoints* in 2008. The theme of the spring issue (#30) was Conflict and Cooperation, while that of the fall issue (#31) was Multilateralism, both important ongoing discourses in the world of international negotiations. *PINPoints* is currently mailed to around 3,000 members of the international negotiations community worldwide.

The SAGE Handbook of Conflict Resolution

The new book, edited by Jacob Bercovitch, Victor Kremenyuk, and I. William Zartman brings together all the conceptual, methodological, and substantive elements of conflict resolution into one volume of 35 specially commissioned chapters. The book helps researchers to understand the opportunities and obstacles to theory building in the field of conflict resolution.

Publications in the Pipeline

Negotiated Risks—International Talks on Hazardous Issues

A new book, *Negotiated Risks—International Talks on Hazardous Issues*, edited by Rudolf Avenhaus and Gunnar Sjöstedt, is to be published in spring 2009 by Springer. The book fills a major gap in the risk literature, bringing together two research strands at IIASA: negotiation and risk. The book focuses on two types of risks: actor-driven, posed by international negotiations themselves, and issue-driven, caused by large-scale human activities. Individual chapters deal with some of the most serious risks facing humanity: climate change, nuclear activities, internal conflicts, and weapons of mass destruction.

Negotiating Climate Change Project

The overall objective of this project is to design and assess approaches and concrete methods for the facilitation of climate talks. One task of the project is to specify the meaning of facilitation, particularly for those measures with a long-term impact. The second task is to analyze how facilitation measures can be designed, how they can be communicated from designer to user, how they can affect the negotiation process, and what results they can attain and why. The project, organized by Gunnar Sjöstedt and Ariel Macaspac Penetrante as co-editors, may develop articles or a focused book as its output.

Unfinished Business: Saving International Negotiations from Failure

The project on failed negotiations, funded by the United States Institute of Peace (USIP), began with a workshop in June 2005, at which lessons from incomplete negotiation encounters were analyzed both from the point of view of particular conceptual approaches and through case studies. The approach avoids a search for a single cause and allows the presentation of multiple reasons for failure and lessons in avoiding them. The book project will be peer-reviewed in 2009. Editors are Guy Olivier Faure and Franz Cede.

Negotiating with Terrorists

The project on Negotiating with Terrorists focuses on when, how, and why negotiations take place between governments and terrorists, given governments' public stance against doing business with terrorists. Two workshops were held in June 2006 and June 2007 to provide a final manuscript, which has now been submitted for publication. The project is supported by the United States Institute of Peace (USIP) and the Smith Richardson Foundation. The book addresses a topic that has hitherto received little systematic attention and will provide an important guide to both analysis and practice. It has already given rise to a *Handbook on Mediation: Negotiating with Terrorists*, by Guy Olivier Faure and I. William Zartman, prepared in conjunction with USIP for the UN Mediation Support Unit.

Participation in other International Conferences/the PIN Network

PIN acts as an ambassador for IIASA, carrying its name into the broad area of social science and international politics, as follows:

Power: Forms, Dynamics, and Consequences Conference, Tampere, Finland

PIN organized a panel on international negotiation during the Power Conference organized by the University of Tampere and Academy of Finland on 22–24 September 2008. Nine papers were presented by international junior level scholars and were commented upon by the PIN Program.

First Latin American Congress on International Migration: Voices of the South, Mexico

Helping to expand the PIN network in South America, PIN represented IIASA at the First Latin American Congress on International Migration, held on 12–14 November 2008 in Toluca, Mexico. PIN presented a paper related to migration, detailing IIASA's current work on education (human capital) and how migration is contributing to the expansion of access to education in labor-exporting countries particularly Mexico, Indonesia, and the Philippines. The paper also highlighted the asymmetrical nature of negotiation between labor-exporting and receiving states.

Other Participation

PIN contributed to a panel at a conference of Deans and Directors of Diplomatic Academies (International Forum on Dip-

lomatic Training) and a panel on EU–Russian relations at the *Diplomatische Akademie in Vienna*.

PIN Coordinator Contributions

In 2008 the PIN Coordinator presented work on "The Dynamics and Mechanisms of Small Arms and Light Weapons and Internal Conflict in the Philippines," to the final conference on Armed Violence held in Brussels on 17–19 March 2008, organized by the Action Group on the Proliferation of Small Arms and Light Weapons (SALW). A second paper entitled "Collective Identity and Group Dynamics—Negotiating Restorative Justice in the Philippines and Thailand," was presented to a forum organized by the Asia Research Institute, National University of Singapore, on 28–29 July 2008.

To mark the start of collaboration between PIN and the Comprehensive Test-Ban-Treaty Organization (CTBTO), the PIN Coordinator was invited to participate as a scientific observer in the Point of Entry (POE) Negotiation of the CTBTO international integrated exercise held on 1–2 September 2008 in Almaty, Kazakhstan. The exercise itself was a large-scale "real-life" simulation of the on-site inspection organized to prepare CTBTO inspectors to carry out future inspection missions.

YSSP 2008

Carolin Görzig from the Ludwig-Maximilian-University, Germany and Louise van Schaik from the Netherlands Institute of International Relations were the PIN YSSPers for 2008. Görzig's paper aimed to derive lessons for mediating identity conflicts from scenario interviews conducted with the Hamas leadership and members in Syria in looking for possible solutions to the conflict with Israel. Van Schaik conducted a case study on the relationship between the unity of the European Union in external representation and its negotiating performance in the World Health Organization (WHO). Furthermore, the PIN YSSPers and Gunnar Sjöstedt organized a lunch bag seminar to discuss professional cultures and how to reach policymakers. In addition, Louise van Schaik and Gunnar Sjöstedt, in cooperation with Fabien Wagner (GGI) and other YSSPers, organized a simulation of the climate change negotiations where IIASA scientists presented their current works as side events.

Activities for 2009

CTBT International Conference

In the mid-1990s, the scientific community played a major role in the negotiation of the global verification regime built to monitor implementation of the Comprehensive Nuclear Test-Ban Treaty. The community of negotiation analysts is now invited to participate in a new analytical endeavor, the International Scientific Negotiation Studies (SNS), the objective of which is to carry out scientific studies assessments to address and evaluate the adequacy of negotiations to establish and implement a verification regime in an international coordination effort. This study is conducted following a similar study by the Provisional Technical Secretariat (PTS) of CTBTO which evaluates eight different technical aspects of the CTBT. The results of the studies will be submitted to the CTBTO and concerned states, to be used as the basis for policy considerations. The PIN study, analyzing and evaluating the negotiation mechanisms that an international system and the technical studies associated with it need in order to make an impact on the real/political world, represents the kind of project that exemplifies PIN. The PIN editing committee is Mark Anstey, Franz Cede, Fen Osler Hampson, Paul Meerts, and I. William Zartman.

Global Negotiations Conference

Victor Kremenyuk is planning to organize a conference on global negotiations on 15–16 June 2009. The conference will be followed by a book analyzing negotiation in global governance, its specifics, function, and capability. The contributors will be almost exclusively IIASA scientists.

Ottawa Negotiation Day

The PIN Roadshow for 2009 is planned for October 2009 in Ottawa, Canada, to be co-organized by Carleton University.

Manila Negotiation Day

The Philippine Ambassador to Austria and Representative to the United Nations, H.E. Lacanlale, invited PIN to conduct a Roadshow in the Philippines which will include a presentation before the government negotiation panel. The Roadshow is planned for November 2009.

CaspiLog 4

The 2009 meeting of the Caspian Dialog is being planned for Astrakhan in September, in cooperation with the International Oceanographic Institute.

Financial Information

As well as the annual contribution from IIASA, PIN Project funding comes from foundations (Smith Richardson), supporting institutions (USIP), and interested agencies (UNESCO, UN Secretariat). Special funding is being sought for CaspiLog from interested foundations and foreign ministries. All work of the Steering Committee is voluntary and unremunerated.

Scientific Recognition

Franz Cede

Invited Lectures/Presentations:

- Andrassy University, Budapest and Salzburg University of Applied Sciences

Advisory Board Membership:

- Senior Advisor of the Austrian Institute for Europe and Security Policy

Victor Kremenyuk

Lectures/Presentations:

- NATO Defense College (Rome) on subjects of Russian national security policy and NATO–Russia relations
- Invited lecturer/professor at the Beirut Christian University, St Paul de la Sagesse (March 2008) on the contemporary international system and the perspectives of conflict resolution.

Advisory Boards:

- Member of the Board, the Russian journal *Issues of Risk Analysis* (a publication of the Russian Scientific Society of Risk Analysis)
- Member of the Board, research and analytical magazine *Observer* (published by the research corporation "Russian-American University")
- Member of the Board, *International Trends* (A Russian Journal of International relations theory and world policy)
- Member of Board of Editorial Advisors, *Peace Review. A Journal of Social Justice* (published in USA by the Taylor and Francis Group, Philadelphia, PA)

Editorships:

- *Problems of Transatlantic Relations at the Beginning of the 21st Century* (published by the Institute for USA and Canada studies (ISKRAN), Moscow, Russia)
- *A New Phase in the Development of International Relations* (published by ISKRAN)

Awards:

- Order of Scientific and Technical Merit for outstanding accomplishment and professional excellence, American Biographical Institute

Paul Meerts

Invited Lectures/Presentations:

- European College, Bruges, Belgium
- Jan Masaryk Center, University of Prague
- University of Leiden, Netherlands
- Workshops in academies and universities in 15 countries

Editorships:

- Culture and International Law, Paul Meerts (ed.), Hague Academic Press - T.M.C. Asser Press and Cambridge University Press 2008 (The Hague)
- The Evolution of International Negotiation Processes (with Raymond Cohen), in: *Journal of International Negotiation* (Washington)

Fen Osler Hampson

Memberships of advisory boards and steering committees:

- Member, American Political Science Association Task Force on Civil Conflict, Political
- Violence and Terrorism
- Executive Committee Member, Canadian Consortium on Human Security
- Board Member, Lester B. Pearson Peacekeeping Centre
- Finance Committee, Lester B. Pearson Peacekeeping Centre
- Board Member, Social Sciences Foundation, University of Denver, Denver, Colorado
- Advisory Board Member, Kashmir Study Group
- Executive Committee Member, APSIA (Association of Professional Schools of International Affairs)

Editorships:

- Series Editor, Conflict Management and Security Studies, Routledge Publishers

Gunnar Sjöstedt

Memberships of advisory boards and steering committees:

- Member of Swedish Academy of Military Sciences,
- Member of International Advisory Board, *Negotiation Journal*

I. William Zartman

Memberships of advisory boards and steering committees:

- Current Vice-President of the Council of American Overseas Research Centers (CAORC).

Ariel Macaspac Penetrante

Invited Lectures/Presentations:

- Final Conference, COST Action Group on the Proliferation of Small Arms and Light Weapons, Brussels (17–19 March 2008)
- Asia Research Institute, National University of Singapore (28–29 July 2008)
- Power Conference, University of Tampere, Finland (22–24 September 2008)
- First Latin American Congress on International Migration: Voices of the South, University of Toluca, Mexico (12–14 November 2008)

Population and Climate Change Program

Brian O'Neill
oneill@iiasa.ac.at

Objectives

The Population and Climate Change (PCC) Program was established in January 2005, primarily funded by a five-year European Young Investigator (EURYI) Award to Program Leader, Brian O'Neill. The PCC Program aims to develop new approaches to interdisciplinary analysis of the climate change issue. Given the disparate aspects of the climate problem— from socioeconomic drivers of greenhouse gas emissions, to changes in the climate system, to political and economic response strategies—there is a strong need for integrative studies. PCC seeks to address this need by advancing integrated assessments of climate change in three areas: 1) understanding links between *demography, energy and emissions*; 2) developing approaches to better account for *uncertainty and learning* (i.e., changes in uncertainty over time); and 3) analyzing *medium-term strategies* that keep open long-term policy options while uncertainties are reduced. While research necessarily includes advances in methodology, the primary aim is to provide better information to the climate policy community to support the development of appropriate responses to the climate issue.

Scientific Achievements and Policy Impact in 2008

In 2008 we built on earlier work to make progress and produce new results in each of our three main projects.

Demography and Emissions

The *demography, energy, and emissions* project aims to explicitly model links between the major demographic trends of aging, urbanization, and changes in living arrangements on the one hand, and energy consumption, land use, and associated emissions on the other. These links include not only how demographic changes might affect future energy demand and emissions, but also how different energy futures would affect aspects of wellbeing such as access to affordable energy sources in developing countries.

Prior work in the project focused on individual country case studies and aimed at investigating the effects of aging in the case of the United States and of urbanization and aging in the case of China and India. Results of the individual country case studies were presented at the Woodrow Wilson International Center for Scholars at a meeting sponsored by its Environmental Change and Security Program in February 2008. The key results highlighted during the presentation were the significant effect on aging of lowering future emissions by a third in the case of the USA and that explicitly accounting for urbanization could lead to emissions projections that are nearly 50 percent higher than projections made without considering the influence of urbanization, as indicated by the case study for China.

The main focus of the work within this project in 2008 was to move from country case studies to a global scenario analysis of the potential effects of demographic change on future energy use and emissions. We developed and employed a nine-region global version of the Population–Environment–Technology or PET model, a computable general equilibrium model with detail in the energy sector. The model draws on substantial data analysis carried out in 2008 of both consumption and production data. Consumption data analysis involved characterizing the economic and energy use behavior of different types of households for several countries, using nationally representative household expenditure surveys for several countries, including Brazil, China, India, Japan, Mexico, Russia, and the USA. Production data analysis characterized the aggregate economic and trade behavior of economies in sectoral detail, using GTAP (Global Trade and Analysis Project) production and trade data. We completed most of the necessary data analysis, and preliminary PET model results for a few regions, with plans to complete the full global analysis in early 2009.

We also continued work on an analysis of the theoretical structure of the PET model, framed within the general problem of grouping economic agents according to their preferences. This work was nearly completed (and will be finalized in 2009), with preliminary results indicating that, given the empirical differences in household economic characteristics found in our data analysis, explicitly disaggregating household decisions into many different groups of households may not be necessary in order to accurately represent aggregate outcomes. A simpler approach to representing heterogeneity may be sufficient.

In addition to work related to modeling future energy scenario, research involving detailed analysis of energy and economic behaviors of individual households was carried out and formed the basis of papers presented by PCC researchers at the 31st International Association of Energy Economics (IAEE) International Conference in Istanbul in June 2008. Work carried out on aspects relating to energy access and its wellbeing implications for the poor during 2008 culminated in a workshop on Energy and Poverty: Clean Cooking Fuels and Technologies, co-organized by Shonali Pachauri in conjunction with the IAEE meeting. The workshop drew together stakeholders from the donor community, business, nongovernmental organizations (NGOs), and universities, these jointly developed an agenda for the future research and action needed for scaling up programs aimed at improving access to clean cooking fuels by the poor.

Uncertainty and Learning

The *uncertainty and learning* project examines the implications of learning (or changes in uncertainty over time) for climate change policy. The anticipation that we will learn more over time plays a key role in climate policy debates, particularly over the appropriate timing of emission reduction policies. For example, some argue that we should postpone substantial emission reductions until we learn more about possible climate change impacts. Others argue that we should make larger, precaution-

ary reductions now, because waiting would risk committing the world to climate impacts that that we might later learn will be more severe than anticipated. Research has not yet provided definitive answers to this question.

The year 2008 saw the publication of two journal Special Issues edited by Brian O'Neill on uncertainty topics. In July a Special Issue of *Climatic Change* on "Learning and Climate Change" appeared. This issue was the outcome of a conference organized by PCC at IIASA in 2006. The meeting brought together leading climate change economists, climate scientists, energy analysts, and demographers to discuss recent work on learning, assess its policy relevance, and identify promising areas of future research. The Special Issue included three papers co-authored by PCC members and IIASA colleagues. In addition, in December a Special Issue of *Environmental Research Letters* entitled "Where Next with Global Environmental Scenarios?" appeared, the result of work during 2008 in writing and editing papers that were products of a meeting on *Global Environmental Futures* co-organized with collaborators at the Watson Institute for International Studies at Brown University in 2007. The conference brought together 20 of the leading scholars and practitioners in the scenario development field. Scenarios have become a standard tool in the portfolio of techniques that scientists and policymakers use to envision and plan for an uncertain future, and the meeting sought to better understand how scenarios are used in the scientific and policy communities, to draw on the experience with scenarios in other issues domains, such as security and energy, and to identify key research questions and needs for improvement. The volume included one paper jointly authored by PCC and IIASA colleagues, as well as an overview paper.

In addition, in 2008 we undertook new analyses of the uncertainty of the climate response to greenhouse gas forcing. In collaboration with postdoctoral fellow Katsu Tanaka, we produced a manuscript which concluded that, currently, the uncertainty in climate sensitivity may be underestimated because insufficient account has been taken of the uncertainty in some forcing factors, particularly that due to sulfate aerosols. We also initiated a study of how uncertainty in this aspect of the climate has changed over the past decades as new data became available, in order to inform thinking about how it may change in the future.

Medium-Term Climate Strategies

The *medium-term strategies* project investigates options for climate policy strategies over the next 30–50 years that help link potential long-term climate change targets to short-term actions. The UN Framework Convention on Climate Change (UNFCCC) sets the ultimate objective of international climate policy as a long-term (century scale) goal of stabilizing atmospheric concentrations of greenhouse gases at a level that is not dangerous. Agreement on such a goal is unlikely to occur soon, given the substantial uncertainties in long-term climate change outcomes and political differences among parties to the UNFCCC. Therefore, strategies for the interim period are needed that keep long-term options open while uncertainties are reduced through learning. Research in this project aims to inform such strategies, drawing on results and tools from the other research areas within the program.

In 2006 an initial paper was published in *Climate Policy* proposing that international climate policy would benefit from the development and adoption of interim concentration targets–that is, a multi-gas target that would limit atmospheric concentrations to a particular level at mid-century. Agreeing to such a target could help limit the rate of climate change over the next several decades, provide more policy certainty for decision makers considering long-term investments, and help keep open the option of achieving a range of long-term climate change targets that we might later decide are necessary to meet. In 2007 PCC presented results of an atmospheric analysis of mid-century targets at an event organized by the Greenhouse Gas Initiative

Special issue of *Climatic Change*

Environmental Research Letters

(GGI) at a preparatory meeting for the Conference of Parties to the UNFCCC.

In 2008 we collaborated with members of the GGI and Energy (ENE) programs on a comprehensive analysis of emissions reduction scenarios consistent with mid-century targets. This analysis used the MESSAGE-based integrated assessment framework to explore relations between mid-century conditions and the likelihood and feasibility of various long-term (2100) climate change outcomes. Results show that goals for limiting climate change in the long term can be associated with mid-century conditions that must be achieved to prevent them from becoming infeasible. They also identify conditions that are optimal from the point of view of mitigation costs, given that particular long-range goals do not become known until the middle of the century. Such results could be useful to climate change policy by providing guidance on conditions that may need to be achieved over the next several decades in order to maintain long-term options. For example, we investigated the "feasibility threshold" related to the stated goal of the European Union (EU) of limiting warming to 2°C, finding that achieving this goal with 50 percent likelihood is technically feasible only if emissions in 2050 are not above about 7 billion tons of carbon. These mid-century conditions can also be expressed in terms of concentrations or according to energy system characteristics. For example, the EU feasibility threshold of 7 billion tons of carbon is also associated with a zero-carbon energy share of 55–60 percent; if a smaller percentage of primary energy is coming from these sources in 2050, then the EU goal is unattainable by 2100.

Activities for 2009

The year 2009 marks the final year of the EURYI-funded PCC program, and therefore our goals focus on completing activities and publishing results. While we will investigate some new topics in 2009, we do not plan to launch any new activities with multiple-year time horizons.

Demography and Emissions Project

In this project we aim to finalize and publish our global analysis of population effects (growth/decline, aging, and urbanization) on emissions. This work will also be accompanied by two to three IIASA Interim Reports containing documentation of data and analysis methods. We also plan to complete at least an illustrative analysis at the country level (e.g., India) that adds additional elements of wellbeing to our energy/economic model, including educational status and possibly energy poverty status. In addition, we intend to complete, and make active, version 1.0 of our user interface to provide a simple means of using the iPETS model via a Web browser.

Uncertainty and Learning Project

We plan to revise and publish our 2008 work on uncertainty in climate sensitivity, and to complete and submit for publication our work on how learning about climate sensitivity may proceed over time.

Medium-term Strategies Project

We plan to submit for publication (in conjunction with collaborators in ENE) the MESSAGE model-based analysis of mid-century targets completed in 2008, and present results in various forums, including the Copenhagen Scientific Congress in March 2009. We will also strive to complete an additional paper with ENE collaborators based largely on existing results but focusing on how mid-century targets relate to rates of climate change rather than to the levels of climate change that are the focus of our current work.

Scientific Recognition

Selected invited lectures

Brian O'Neill

- Woodrow Wilson International Center for Scholars, Washington, DC, USA: *Population and climate change: Relationships, research, and responses.*
- Energy Modeling Forum-22, Uncertainty Subgroup, Wesleyan University, USA: *Population, uncertainty, and learning in climate change decision analysis.*
- Joint Global Change Research Institute, University of Maryland, USA: *Demographic trends and implications for greenhouse gas emissions.*

Shonali Pachauri

- Institute of Social Ecology (IFF), Vienna: *Socioeconomic and Demographic Dimensions of Energy Access and Use in Developing Countries*.
- Pre-Conference Workshop on "Energy and Poverty: Clean Cooking Fuels, and Technologies," Istanbul, Turkey: *The Use of Indicators for Dovetailing Policies Regarding Energy and Poverty*.
- 31st IAEE international conference "Bridging Energy Supply and Demand: Logistics, Competition and Environment," Istanbul, Turkey: *Regional Decomposition of Domestic Electricity Consumption in India: 1980–2005*.

Katsumasa Tanaka

- Conference, "New Methodologies and Interdisciplinary Approaches in Global Change Research," Ile de Porquerolles, France: *A New Methodology to Estimate Climate Sensitivity*.

Katarina Zigova

- 31st IAEE international conference "Bridging Energy Supply and Demand: Logistics, Competition and Environment," Istanbul, Turkey: *Effect of Household Age and Size on the Elasticity of Energy Consumption*.

Selected Editorships

Brian O'Neill

- Editorial Board, *Environmental Research Letters*.
- International Editorial Board, *Global Environmental Change*.
- Associate Editor, *Population and Environment*.
- Editorial Board Member, Integrated Assessment Domain, *Wiley Interdisciplinary Reviews—Climate Change*.

Awards

Brian O'Neill

- Elected member of the newly established body of young scientists (*"Junge Kurie"*) of the Austrian Academy of Science, May 2008

Risk and Vulnerability Program

Joanne Linnerooth-Bayer
bayer@iiasa.ac.at

Objective

In its third year the Risk and Vulnerability Program (RAV) continued progress in meeting its objective: *advancing scientific inquiry and assisting the development of policy strategies that promote adaptation and resilience of societies and ecosystems to stresses imposed by global-change phenomena*.

Scientific Achievements and Policy Impact in 2008

RAV achievements can be described within it three research groups: *Disasters and Development; Decisions and Governance; and Water and Resilience*.

Disasters and Development

The *Disasters & Development* research group—through systematic modeling of the global drivers of natural disaster risk and its physical, financial, and economic consequences—is helping communities, governments, and the international community to assess how risk can be reduced, absorbed, and transferred.

The international donor community should consider supporting pre-disaster insurance instruments as a partial alternative to post-disaster assistance. This is a core message of RAV's work in this area (published in *Science* 2005), a message that has influenced policy at the World Bank, Inter-American Development Bank (IADB), the United Kingdom Department for International Development (DFID) and other financial/development institutions, and is currently resonating in the climate community. The United Nations Framework Convention on Climate Change (UNFCCC) specifically calls for consideration of risk sharing and transfer mechanisms, such as insurance, as a means to address loss and damage in developing countries that are particularly vulnerable to climate change. Following an IIASA workshop on this topic in 2007, RAV scientists drafted a submission on the part of the Munich Climate Insurance Initiative (MCII) that proposes a risk management module—funded by a post-Copenhagen adaptation fund—consisting of two pillars: prevention and insurance. Global facilities would offer technical support and capitalization of fledgling insurance programs in vulnerable countries. The rationale and summary of this proposal were published as an IIASA Policy Brief, "Climate Change: What Role for Insurance?," presented at the plenary at COP 14 in Poznan. As extensive press coverage demonstrated, **the IIASA/MCII proposed global risk management facility has a good chance of influencing the Copenhagen outcome on an adaptation strategy.**

The idea and rationale of a global risk management module build on extensive work by RAV staff: supporting Mexico in issuing the first developing country sovereign cat (catastrophe) bond; reviewing catastrophe micro-insurance systems; evaluating an innovative index-based crop insurance system in Malawi; developing the CATSIM model for advising governments on disaster financing in the Caribbean, Madagascar, Philippines, and elsewhere; and numerous workshops and training seminars on this topic.

The argument for supporting risk financing as part of a climate adaptation strategy depends importantly on the future impacts of climate change on weather-related disasters. Scientists know that economic losses from storms, floods, and other hazards have increased dramatically over the last decades, but they are unsure how to forecast these losses to the near and distant future. Past trends can be almost fully explained by expanding population, capital, and wealth as it moves into harm's way. Yet, will these socioeconomic factors continue to dominate the future trend, as most (albeit scant) research shows, or will climate change play an increasing or even dominant role? RAV examined this question by simultaneously modeling climate-related and socioeconomic drivers in Bangladesh, and concluded that **both global and climate drivers will likely be of similar magnitude in contributing to future disaster losses in highly exposed Bangladesh**. A similar result was reached for Mozambique, described in the next section.

Supported by the World Bank, RAV scientists, Reinhard Mechler, Georg Pflug, and Stefan Hochreiner, also examined the effect of climate change on a novel, index-based crop insurance program for subsistence farmers in Malawi. The RAV analysis, which combined catastrophe insurance modeling with climate modeling, showed that **climate change will likely decrease the financial robustness of the Malawian insurance pool over the next few years and necessitate additional back-up capital**. Research of this sort strengthens the case for a global facility that can provide the necessary capitalization.

Is the European Union (EU) also vulnerable to increasing risks of floods, windstorms, droughts, and other climate-related disasters? This question underlies the RAV-led work package of the EU-supported ADAM project. Together with its partners, RAV has: (i) mapped asset risks to flooding and droughts in Europe for today's and future climates (direct risks); and (ii) estimated economic vulnerabilities and risks for the public and selected sectors (indirect risks). **For the first time, probability-based and spatially explicit disaster maps are available across Europe. This research shows that, even today, most of the newest EU member states are facing annualized flood damage greater than 1 percent of their GDP**. Moreover, as hazards and risks are projected into the future (2020 and 2090), there is a considerable increase in intense precipitation and other weather extremes in comparison to the period 1961–1990. Applications of CATSIM-macro show that governments of hotspot regions, such as the Tisza River basin in Hungary, are ill-prepared to respond to high-consequence climate disasters.

In 2008 CATSIM went local. To examine whether prevention pays for a poor farm household facing high flood and drought risks, CATSIM-micro examined exposure, risk, and vulnerability of a typical household in Uttar Pradesh, and evaluated risk pre-

vention and transfer options. Further analyses at the macro scale in India, Pakistan, and Nepal explicitly showed that **preventive measures can generate economic returns that are competitive with other public investments**, although some "soft" measures, such as early warning, appeared superior to "hard" measures, such as flood defenses. This research was carried out by RAV researchers, Reinhard Mechler, Georg Pflug, Stefan Hochrainer, Daniel Kull, Fawad Khan, Unmesh Patnaik, and Harvir Kalirai, as part of a DFID-sponsored project, led by the Katmandu-based Institute for Social and Environmental Transition (ISET). It required advanced forms of cost-benefit analyses that take account of probabilistic impacts far into the future. The Indian study is already proving useful in promoting stakeholder dialog, and RAV will present results at a ministerial-level meeting in Delhi in early 2009.

Decisions and Governance

The *Decisions and Governance* (DAG) group investigates how the presence of risk and uncertainty influences the design of successful policies in areas of environmental management and climate change. Among other activities, in 2008 this RAV group looked closely at vulnerability: how to measure it, its relevance for policy decisions, and how it is related to development. Some highlights follow.

Indicators and metrics describing vulnerability to climate change are viewed by many as essential for allocating resources for adaptation, especially for the developing world. This was evidenced especially by a 2008 World Bank–organized international consultation with experts from 16 countries to identify the best metrics for this purpose. A book edited by RAV's Anthony Patt, however, argues that **aggregated indicators and metrics of vulnerability can actually hamper policymaking for adaptation**. This finding is based on multiple case studies showing that vulnerability indicators are often poorly matched to actual policy problems and more difficult to interpret and defend than the underlying data. In *Assessing Vulnerability to Global Environmental Change: Making Information Useful for Adaptation Policy and Decision-Making* (Earthscan), Patt and his co-editors find that assessments are more likely to influence policy if they deliver simple and easily understandable information rather than aggregate quantifications of vulnerability.

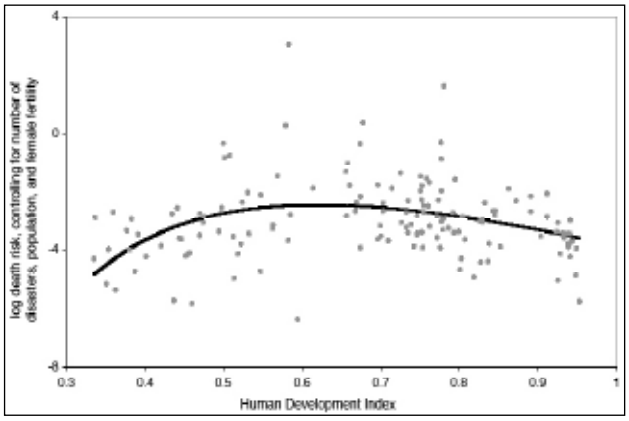


Figure 1. IIASA scenarios of climatic risk show that risk levels follow a "Kuznets Curve" pattern—peaking at medium levels of development—even when including other explanatory variables.

With World Bank funding, RAV contributed to a Mozambique government–sponsored assessment of the risks Mozambique faces from climate change, especially increased risk of droughts, floods, and tropical cyclones, through the year 2060. RAV scientists developed scenarios of climate risk based on three sources: (1) a statistical analysis of deaths and displaced people from natural disasters 1990–2007; (2) an extrapolation of current trends, and taking account of down-scaled global climate models' predictions of changing return periods (in partnership with the University of Cape Town); and (3) development of scenarios of the Human Development Index by combining IIASA scenarios and other United Nations projections. Interestingly, the results of the latter worldwide analysis replicated previous results showing that risk levels follow a "Kuznets Curve" pattern—peaking at medium levels of development—even when including other explanatory variables, such as urbanization or the number of disasters (see *Figure 1*).

With a three-pronged approach RAV researchers were able to show **that in Mozambique, socioeconomic development would more than compensate for the changing risk levels predicted by climate models, but would not compensate for changing risk levels generated by an extrapolation of current trends**. For some socioeconomic scenarios, risk levels would peak before mid-century, and then decline, as Mozambique's development progresses beyond the Kuznets Curve "hump." This work complements the study of climate change and disasters in Bangladesh mentioned above.

Finally, the DAG group initiated a new and intriguing research venture, the potential and associated risks of large-scale solar facilities in Africa to provide electricity to Europe. A first exploratory workshop was held at IIASA, and funds have been secured to pursue this topic further in 2009. Another exciting activity has been exploring perceptions and understanding of climate risk and micro-insurance products by small-holder farmers in Africa, and also the use of games for building this understanding. This research shows that **games do not fare better than conventional communications for promoting understanding of probabilistic information, but follow-up work will examine if retention is greater when information is conveyed through gaming exercises**.

Water and Resilience

The *Water and Resilience* group has organized stakeholder-driven dialogs, informed by systems modeling, in the Tisza and Odra river basins. These participatory processes have elicited local knowledge and formed the basis for conceptual and formal models of vulnerability, resilience, and adaptive capacity of the social-ecological systems in these river basins. A motivating issue for these policy dialogs has been: How can water management policies be transformed to promote the sustainable development of river basins?

One clear message emerging from EU-funded projects, NeWater and SCENES, is that "regime shifts" cannot be brought about by "top-down" or "bottom-up" processes if actors act independently. To better understand the dynamics and interactions of water managers and farmers, RAV researchers, Jan Sendzimir and Piotr Magnuszewski, have developed a system dynamics model of floodplain agriculture that drives an inter-

active game. In preliminary tests, participants—Hungarian students, Spanish policymakers, and scientists—have assumed the roles of farmers and water managers. In all cases, **participants were surprised and impressed that their aspirations could not be realized unilaterally, that is, that there was a need for mutual interactions**. Testing will continue with scientists and policymakers in Belgium and Hungary to make the game a fully accessible resource for education and knowledge elicitation.

Activities for 2009 (selected)

RAV will continue 2008 research with the following anticipated highlights:

- Workshop involving United Nations Framework Convention on Climate Change (UNFCCC) and United Nations Development Programme (UNDP) on the architecture of a global risk management facility (Joanne Bayer);
- Contribution to the World Development Report on disaster risk financing in the developing world, as well as invitation to join core writing team on UN–World Bank report on economics of disaster risk reduction (Reinhard Mechler);
- Special issue: Mitigation and Adaptation Strategies on Adaptation to Climate Change in Europe (co-editor Reinhard Mechler; and
- Workshop and research on renewable energy investment and electricity imports from North Africa to Europe funded by the European Climate Foundation (Anthony Patt);
- IIASA workshop on geo-engineering solutions to climate change that will build on a report from a California workshop on this topic (Jason Blackstock);
- Publication of two special journal editions: "Vulnerability in the Tisza River Basin," and "Catastrophe Modeling" (Aniello Amendola);
- Finalization of planned book on *Ideas of Fairness* that will focus on global risk issues (Michael Thompson);
- Continuation of EU-funded SCENES research on the ecological, social, and economic factors affecting the resilience and adaptive capacity of European river basins (Jan Sendzimir);
- Finalization of Adaptation project and continuation of collaboration with IIASA Greenhouse Gas Initiative (Reinhard Mechler, Joanne Bayer, Anthony Patt);
- Initiation of research on newly funded EU project on Living with landslide risk in Europe (SafeLand) (Joanne Bayer, Anthony Patt, and Jan Sendzimir);
- Participation in the Chinese (BNU) project for Disciplinary Innovation of Universities (led by Peijun Shi and Roger Kasperson).
- Collaboration with Wharton and Risk Management Solutions on a World Bank–funded project examining risk and vulnerability of developing countries to natural hazards (Joanne Bayer and Reinhard Mechler).
- Joint IIASA/DPRI annual conference on "Integrated Disaster Risk Management" in Kyoto (University of Kyoto, Beijing Normal University, and IIASA) (Reinhard Mechler, Aniello Amendola, Joanne Bayer)

Scientific Recognition

- Jan Sendzimir: Sustainability Fellow, Kennedy School of Government, Harvard University.
- Joanne Bayer: Invited to participate on the EC Environment Advisory Group and the board of the Austrian Climate Research Program. Invited member of Science Committee of the Chinese Academy of Disaster Reduction and Emergency Management.

Selected Invited Lectures

- Jan Sendzimir: Invited presentation, "Food Security and Environmental Change," Global Environmental Change and Food Systems (GECAFS) conference, Oxford University (April 2008)
- Anthony Patt: Tällberg Forum, Tällberg, Sweden, invited participant in Forum, and contributor to "redesigning workshop" on a Zero Carbon Energy System (June 2008).
- Reinhard Mechler: Invited presentation at World Bank on economics of disaster risk reduction (October 2008)
- Joanne Bayer: Invited presentation on "Climate Change and Insurance" at conference, "The Irrational Economist," in honor of Howard Kunreuther, Wharton (December 2008).

Selected Editorships

- Jan Sendzimir (guest editor). *Ecology and Society*, "New Methods for Adaptive Water Management."
- Anthony Patt, Dagmar Schröter, Richard Klein, and A.C. de la Vega-Leinert (eds.). *Assessing Vulnerability to Global Environmental Change: Making Information Useful for Adaptation Policy and Decision-Making*. London: Earthscan.
- A. Amendola, J. Linnerooth-Bayer, N. Okada, and P. Shi (eds.) "Towards integrated disaster risk management: case studies and trends from Asia." *Natural Hazards* 10.1007/s11069-007-9152-z.
- Anthony Patt: *Global Environmental Change*, International Editorial Board; *Regional Environmental Change*, Editor; *Climate and Development*, Associate Editor
- Joanne Linnerooth-Bayer: *Journal of Risk Research*, Associate Editor; *Risk Analysis*, Associate Editor; *Journal of Natural Resources Policy Research*, International Editorial Board
- Georg Pflug: *Computational Management Science*, Editorial Board; *Mathematical Methods of OR, Computational Optimizations and Applications*, Editorial Board

World Population Program

Wolfgang Lutz
lutz@iiasa.ac.at

Objectives

IIASA's World Population Program (POP) works on the quantitative aspects of human populations, right at the cutting edge of the scientific analysis of global change. It also provides science-based policy advice at the highest level to the European Commission, national governments, and United Nations (UN) agencies. As stated in the 2006–2010 Research Plan, POP's main focus is on the dynamics of global population change and its interactions with changing social, economic, and environmental conditions. Special emphasis is given to the modeling of the dynamics of human capital formation, including its reconstruction and projections for as many countries as possible. This includes comprehensive analysis of the economic, social, and health returns of investments in education based on new data, as well as analyses of societies' future adaptive capacities to climate change. To meet this ambitious objective, POP makes use of an extensive global network of regional population centers and functions as the scientific node for these regional activities.

Scientific Achievements

The Acceleration of Global Population Aging

In 2008 POP published its third update of probabilistic world population projections for 13 world regions. As with the two previous projections, these results were published in the journal *Nature.* The first-ever global probabilistic population projections were produced in 1996 by POP and published in an IIASA book entitled *The Future Population of the World: What Can We Assume Today?* (London, Earthscan) and were summarized in Nature ("Doubling of world population unlikely," Vol. 387, pp. 803–805, 1997). Several years later, a new assessment based on newer data and improved methodology was published in Nature ("The end of world population growth," Vol. 412, pp. 543–545, 2001). This publication resulted in extremely wide international media coverage. A more detailed description of these projections was published in the IIASA book, *The End of World Population Growth in the 21st Century: New Challenges for Human Capital Formation and Sustainable Development* (London, Earthscan). The results of these new projections were published in *Nature* in February 2008 ("The coming acceleration of global population ageing," Vol. 451, pp. 716–719).

These new projections use the same methodology and essentially the same long-term assumptions as the 2001 projections, but the focus now is on the expected speed of population aging rather than population growth. The new projections also reflect the most recent demographic trends up to 2006. Given the great sensitivity of long-term demographic trends to starting conditions and initial trends, this reflection of the most recent empirical trends changes the regional population outlook to some extent. As fertility in China has declined faster and to a lower level than was previously assumed, the long-term population of China emerges as lower than before, with aging occurring more rapidly. In sub-Saharan Africa, on the other hand, fertility declined more slowly than assumed, and the decline actually showed a stagnation in some countries which translated into more rapid population growth in that region. On the global level, the higher growth in Africa and the lower growth in China almost compensate for each other, so that our previous estimate of an 88 percent probability of the world population peaking before the end of the century remains virtually unchanged.

These new projections were also featured in the 2008 issue of the widely circulated newsletter *POPNET* (No. 39).

Rethinking Age and Aging

In 2008 POP completed some pioneering work, the results of which mean nothing less than a complete redefinition of the concept of age. While traditionally measured as the time since birth, this new concept of age also considers the expected time to death, which is quite different in times of increasing (healthy) life expectancy. Phrases such as "40 is the new 30" capture this different meaning of age. While some of the aspects of this research were included in the above-mentioned contribution to *Nature* (2008), a much more extensive and prominent piece was published by Warren Sanderson and Sergei Scherbov as the December 2008 issue of *Population Bulletin* ("Rethinking age and aging," Vol. 63, No. 4, Population Reference Bureau). This 20-page publication addressed a very broad audience and studied the dynamics of change of conventional as well as new measures of age and aging for different world regions in a comparative perspective.

Production of European and Asian Data Sheets

In 2008 IIASA's Population Program (in collaboration with the Vienna Institute of Demography [VID] of the Austrian Academy of Sciences and the USA-based Population Reference Bureau) published the "European Demographic Data Sheet 2008" with key demographic indicators for 48 European countries. While this included some more conventional indicators, it also published for the first time important new indicators (such as the tempo-adjusted total fertility rate and the proportion of the population with a remaining life expectancy of 15 years or less) in a consistent way for all countries (see *Figure 1*). This was complemented by in-depth analyses, which were printed on the back of POP's wall chart. Several thousand copies of this data sheet were distributed across Europe and in particular at the European Population Conference in Barcelona and the Second European Demographic Forum in Brussels.

As part of the Asian MetaCentre for Population and Sustainable Development Analysis (a collaborative effort of IIASA with the National University of Singapore and Chulalongkorn University in Bangkok), IIASA produced the "Asian Demographic and Human Capital Data Sheet 2008," which was widely distributed

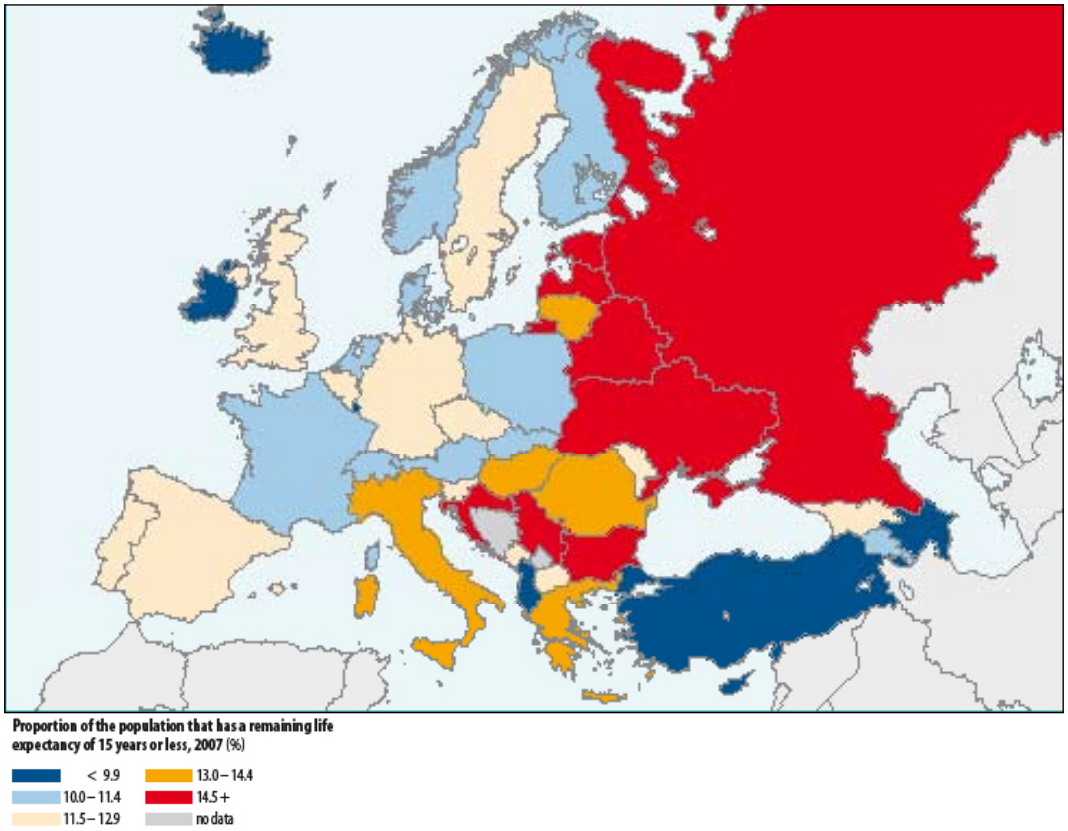


Figure 1. Proportion of the population in Europe that has a remaining life expectancy of 15 years or less, 2007 (percent): one of the important new indicators from the European Demographic Data Sheet 2008.

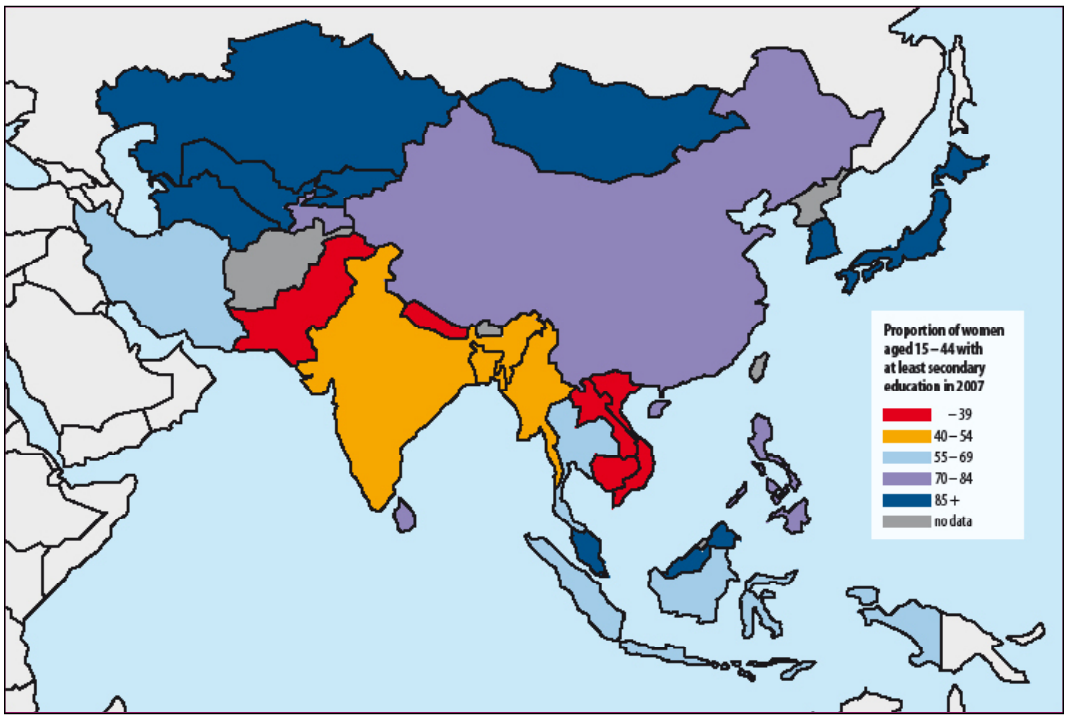


Figure 2. Proportion of women in Asia aged 15–44 with at least secondary education in 2007: one of the important new indicators from the Asian Demographic and Human Capital Data Sheet 2008.

throughout Asia. As well as the ususal demographic indicators, it lists the new IIASA/VID educational attainment data (reconstructions and projections) for 1970, 2007, and 2030 for 26 Asian countries. Among the indicators listed were selected age-specific proportions of women with different levels of educational attainment (see *Figure 2*). The wall chart also gives a summary of the dynamics of change of educational attainment by age and sex.

The Demography of Educational Attainment and Economic Growth

In February 2008 Wolfgang Lutz, Jesus Crespo Cuaresma, and Warren Sanderson published a Policy Forum in *Science* ("The demography of educational attainment and economic growth," Vol. 319, pp. 1047–1048). This for the first time presented consistent statistical evidence that improvements in education, and thus human capital, do indeed have consistently positive effects on economic growth rates. While it had already been established beyond reasonable doubt that more education tends to result in more income at the individual level, evidence that the same was true at the macro level had not been that clear. The main reason for this was incomplete and otherwise deficient human capital data. The newly reconstructed IIASA/VID data by age, sex, and four levels of educational attainment provided a new and more consistent basis for reestimating the standard economic growth regressions.

The *Science* article presented and discussed this new evidence. The study finds that the current Millennium Development Goal of universal primary education should be complemented by the goal of secondary education over broad segments of the population, as only secondary education will provide the necessary and desired development push to bring countries out of poverty. In the industrialized countries, tertiary education for the younger adult population emerges as being of utmost importance.

Education and Human Capital Projections to 2050

Using the method of multi-state demography (which was developed at IIASA during the 1970s), POP produced the first global projections by level of educational attainment at the level of individual countries. These projections are based on four alternative education scenarios: 1) the Fast Track Scenario assuming the fastest possible expansion of the education system; 2) the Global Education Trend Scenario, which assumes that future improvements follow the trend of past improvements in all countries of the world; 3) the Constant Enrollment Ratio Scenario; and 4) the Constant Enrollment Number Scenario, which assumes no new schools, resulting in declining enrollment rates in the case of population growth. As fertility levels differ greatly by level of education, these different education scenarios also result in greatly differing population outcomes. The projections have been published in Projection of Populations by Level of Educational Attainment, Age and Sex for 120 Countries for 2005–2050, *IIASA Interim Report IR-08-038* by K.C. Samir, Bilal Barakat, Anne Goujon, Vegard Skirbekk, and Wolfgang Lutz

Age and Productivity Capacity: Descriptions, Causes, and Policy Options

In an article in *Ageing Horizons* ("Age and productivity capacity: Descriptions, causes and policy options," Vol. 8, pp. 4–12, Oxford Institute of Ageing, 2008), Vegard Skirbekk reviews how work performance differs over the life cycle by describing and discussing findings from a range of different approaches. He also considers the causes of productivity variation by age, with a particular focus on experience and cognitive abilities. His findings suggest that productivity tends to increase during the initial years in the labor market before it stabilizes and often declines toward the end of the working life. Policies that could boost productivity among senior workers are discussed, including increased on-the-job training, educational programs, and more promotion of health. Moreover, a better age mix in the workplace, allowing older and younger individuals to benefit from their comparative advantages, is likely to improve overall productivity in aging nations.

Activities for 2009

In 2009 POP will continue to pursue the research agenda as described in the Research Plan 2006–2010 and continue work on the new European Research Council project, FutureSoc.

Scientific Recognition

ERC (European Research Council) Advanced Investigator Grant

Wolfgang Lutz was awarded this new and highly prestigious personal grant for a study on "Forecasting Societies' Adaptive Capacities to Climate Change" (FutureSoc). He was the only demographer and one of just a handful of social scientists to win this most competitive European-level award, which comes with €2.5 million. The work will be carried out at IIASA over the coming five years.

Election to the Austrian Academy of Sciences

In 2008 Wolfgang Lutz was elected as a corresponding member (kMI) of the Austrian Academy of Sciences.

Selected Invited Lectures

Wolfgang Lutz

In 2008, Lutz gave 27 lectures in 15 different countries. Highlights are:

- Plenary keynote address "World Population and Human Capital" at the Club of Rome's 40th Anniversary Conference and Centennary of Aurelio Peccei, Auditorio Roma, 17 June
- Concluding plenary keynote "The Coming Acceleration of Global Population Ageing" at the Annual Meeting of the Royal Statistical Society, Nottingham, 5 September
- Plenary address "Alternative trends for human capital in Africa" at the East African Conference of Education Ministers on Urban Education, Nairobi, 14 November
- Opening plenary keynote "Recent demographic trends in Europe and the World" at the Second European Demographic Forum, EU Commission, Brussels, 24 November

Sergei Scherbov

- Presentation "Population Dynamics and Forecasting" at the Office of the Deputy Prime Minister for Information Affairs, Abu Dhabi, United Arab Emirates, 14 June
- Lecture on "Aging: A New Look into an Old Problem" at the International Conference on Multifacetal Aspects of Aging and Aging Diseases, Peking University, Beijing, 29 October

Vegard Skirbekk

- Presentation "Reconciling Work and Family Life" at the European Parliament, Brussels, 14 February
- Presentation "Age, Productivity and Cohort Effects" at the MacArthur Foundation Aging Society Network, Rockefeller Foundation/Bellagio, 20 May
- Presentation "Is Japan Caught in a Low Fertility Trap?" at the International Conference on Low Fertility and Reproductive Health in East and Southeast Asia, Nihon University Population Research Institute, 12 November

Anne Goujon

- Presentation "New Times, Old Beliefs: Future Importance of Religions in Austria, Switzerland, and Canada" at the Conference on Demography and Culture, International Association of Francophone Demographers, Quebec, 29 August

POP Editorships

- Jesus Crespo Cuaresma: International Editorial Board Member: *Empirica: Journal of European Economics; Panoeconomicus*.
- Wolfgang Lutz: Editor, *Vienna Yearbook of Population Research*, Austrian Academy of Sciences; Associate Editor, *International Statistical Review*, the official journal of the ISI (International Statistical Institute and the Bernulli Society); Co-editor, *Asian Population Studies*, Routledge; Reviewer, *Demographic Research*, an online journal of the Max Planck Institute for Demographic Research; Editorial Board Member, *European Population Studies*, the official journal of the European Association for Population Studies (EAPS); Editor, Earthscan scientific book series on *Population and Sustainable Development*; Associate Editor, *Canadian Studies in Population*, Population Research Laboratory, University of Alberta
- Warren C. Sanderson: Reviewer, *Demographic Research*.

Part III

Energy and Technology

Dynamic Systems Program

Arkady Kryazhimskiy
kryazhim@iiasa.ac.at

Objectives

In 2008 DYN organized research in four areas: *Assessment of Dynamical Systems (ADS), Driving Forces of Economic Growth (ECG), Fragility of Critical Infrastructures (FCI), and Environmental Applications (ENA).* ADS extends DYN's earlier studies in methodology; it is aimed at developing methods for analysis of large-scale dynamical systems and at using these methods to support research in the areas of ECG, FCI, and ENA. ECG is based on DYN's earlier research on assessment of technological dynamics. Since 2007 ECG activities have pursued the goal of consolidating studies on critical aspects of economic development, which had been carried out from different disciplinary perspectives in different IIASA groups. In 2008 ECG-based research used theoretic and data-based analyses to characterize long-lasting feedbacks between economic growth and development of aggregate production factors such as useful work, transportation infrastructure, and health. FCI was launched in 2007 to form the basis for a new cross-program IIASA initiative focusing on assessment and management of critically important infrastructures, such as those that support flows of energy, transport, money, and information. FCI received a first research impulse in 2008. ENA continues DYN's research in the areas of environmental management and ecology.

Scientific Achievements and Policy Impact

Assessment of Dynamical Systems: Equilibrium Development of Interacting Economic Agents Project. From a methodological perspective, this new project finds a new application for the notion of market equilibrium, which has previously been successfully used to resolve emission reduction games. The market of emission reductions has no established currency; the final decisions are made through "subjective" bilateral exchange rates. DYN suggested that a similar idea may lie behind the equilibrium codevelopment of selfish economic agents that interact in a market environment. Each agent may use his/her own capital resources to estimate his/her own "subjective" prices for the goods produced by the other agents. The agents' individual policies responding best to those "subjective" prices form an equilibrium policy of the community of the agents. A game-theoretic analysis of a stylized model of the agents' dynamics lead to a closed-form description of the market equilibrium behavior. The latter possesses interesting robustness properties, the most remarkable of which is that the agents' capital saving rates are insensitive to fluctuations in market prices.

Assessment of Dynamical Systems: Infinite-Horizon Growth Project. This project develops DYN's earlier studies which were motivated by problems of optimization of long-term economic growth.[1] The studies contribute to the mathematical theory of optimal control and provide a basis for applications in the area of ECG. The theoretical analysis confronts serious technical difficulties— singularities—emerging from the fact that (in a mathematical idealization) growth processes have infinite durations. For that reason, a classical instrument of optimal control theory—the Pontryagin maximum principle—may take different forms in different situations. In 2008 DYN researchers concentrated on a situation where the discount parameter in the integral utility index dominated the growth parameters of the underlying model. Theoretical results were used to characterize the optimal capital accumulation policy for an enterprise. Another application focused on a model of a two-sector economy affected by a random shock. The model assumes that a "lagging" sector of the economy produces goods for consumption while the products of the economy's "booming" sector (these could be, for example, natural resources) remain highly profitable until the market price for those products survives a random shock. The study suggested an approach to finding the optimal distribution of investments in the development of the two economy sectors.

Driving Forces of Economic Growth: Simulation of Optimal Economic Growth Project. In 2008 the project focused on a model of economic growth in a country in which capital, labor, and useful work serve as production factors. The model assumes that scenarios for labor and useful work are given exogenously and that the capital saving rate acts as a free control variable intended to maximize the country's utility—a consumption index integrated with a discount over an infinite time period. Theory of optimal control was used to characterize the optimal growth trends (in particular, a methodology suggested by the *Infinite-Horizon Growth Project* was used). The theoretical findings were implemented in a numerical algorithm. The algorithm was used to calibrate the model and to simulate future optimal growth scenarios. Time series for the United Kingdom (UK), the United States (USA), and Japan were analyzed in detail. shows a family of optimal capital-per-worker growth trajectories for the UK. The trajectories were simulated using expanding windows of data for model calibration: 1950–1974 (dark blue); 1950–1984 (lavender); 1950–1994 (orange); and 1950–2004 (blue). The real time series for the period 1950–2004 is shown in red. It is remarkable that the 30-year, 20-year, and 10-year forecasts provided by the first three simulated trajectories fit with the real time series; the proposed forecasting technique is reliable for medium time horizons. The long-run forecasts—the saturation levels on the simulated trajectories—converge as the underlying data series expand.

[1] A.V. Kryazhimskiy and C. Watanabe (eds), Optimization of technological growth, GENDOITOSHO, Kanagava, 2004; S.M. Aseev and A.V. Kryazhimskiy, The Pontryagin maximum principle and optimal economic growth problems, Proceedings of the Steklov Institute of Mathematics, 2007), 1–255.

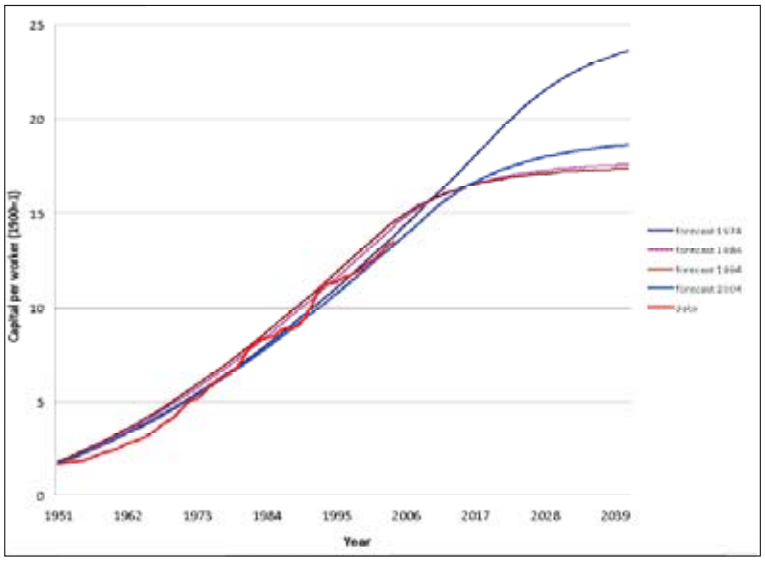


Figure 1. Model- and data-based growth forecasts for the UK. Four optimal capital-per-worker growth trajectories simulated using expanding windows of data (red) – 1950-1974 (dark blue); 1950–1984 (lavender); 1950–1994 (orange); and 1950–2004 (blue).

Driving Forces of Economic Growth: Pollution and Growth Project. The project's goal is to understand how the decline in environmental quality caused by increasing production affects economic growth. In 2008 the study used a stylized economic growth model incorporating linkages between population growth, industrial development, and air pollutions. The model assumes that there is a trade-off between consumption and environmental mortality; in this light, health is one of the competing goals for utility-maximizing agents. Methods of optimal control (particularly, those originating from the *Infinite-Horizon Growth Project*) were used to generate optimal growth scenarios. An application of the model to 14 European Union (EU) countries revealed a negative association between the number of deaths in 2020 and the average economic growth rate in 2000–2020. To validate the model, DYN researchers compared the simulated PM 2.5 emission projections for 2020 with those provided by IIASA's large-scale RAINS (Regional Air Pollution Information and Simulation) model. *Figure 2* shows that the projected emissions differ for France, Spain, and the UK, whereas the other countries provide relatively close numbers.

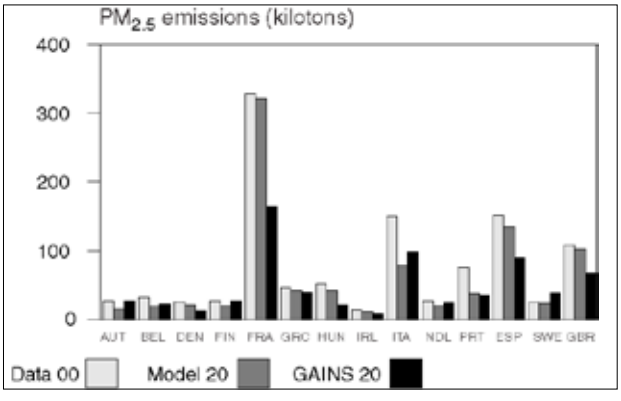


Figure 2. The projected levels of PM 2.5 emissions in 2020, provided by a simplified optimal control model (grey) and IIASA's large-scale RAINS model (black) for 14 EU countries. The emission levels differ for France (FRA), Spain (ESP) and the UK (GBR); the other countries show relatively close numbers. Data for 2000 are shown in light grey.

Driving Forces of Economic Growth: Negative Investment and Optimal Growth Project. Usually, economic growth models assume that consumption never exceeds the size of the current output. The investment capacity is generally enlarged by removing that constraint and allowing a negative investment to be made, in order to allow more to be consumed than has been produced. DYN researchers analyzed a simplified one-factor growth model equipped with a logarithmic utility to determine whether the negative investment option is able to improve the process of economic growth. A final statement claims that if the planning horizon is infinite, the negative investment option does not improve the growth process; in other cases it improves the growth process by raising the optimal value for the utility, although the improvement is usually insignificant.

Driving Forces of Economic Growth and Fragility of Critical Infrastructures: Transportation Infrastructures and Economic Growth Project. This project addressed the issue of co-development of a country's gross domestic product (GDP) and transport infrastructure. The study used a simplified dynamical model whose state variables accounted for the capacity of the roads in the country and the country's GDP, and whose decision variable represented annual growth in the capacity of the roads. The model assumes that the present capacity of the roads establishes a critical level for the GDP, above which GDP growth is not supported by the existing infrastructure. The model is coupled with an integrated utility index reflecting the country's desire to increase its GDP and to reduce its costs for maintaining/increasing the capacity of the roads. The Pontryagin maximum principle (see the *Infinite-Horizon Growth Project*) was used to describe the model's optimal trajectory. The latter converges to a steady state, indicating that a given technology for the construction of the roads is unable to support infinite growth of the economy. The model was used to simulate future growth scenarios for several EU countries. *Figure 3* presents the simulation results for France. The project was carried out by DYN and Forestry (FOR) researchers.

Fragility of Critical Infrastructures: Network Analysis of Energy Infrastructures Project. The project suggested an aggregated model for the Eurasian natural gas transportation infrastructure. The model views Russia, Central African countries (CAC), Middle East countries, northern Africa, and Norway as gas suppliers, Eastern European countries as transit countries, and the EU25 and Northeast Asia (NEA) as final energy consumers. Network analysis, a common tool in assessment of ecological networks, was used to characterize pair-wise relations between the system's compartments as either positive

(mutualism) or negative (antagonism). The ratio of the numbers of the positive and negative relations in the network defines the network's utility. An analysis of the utility values under varying "virtual" flows from Russia to the EU25 showed that Russia and the EU25 are in positive relations in the majority of situations, and the decline in the flows traveling through the transit countries usually tends to increase the utility value. In addition, the DYN-elaborated GASCOM (Gas Market Competition) model was used to assess competing export projects planned for the Chinese gas market. The study included analysis of the sensitivity of the projects' parameters to variations in projected demand and price.

Fragility of Critical Infrastructures: Qualitative Risk Assessment and Agent-Based Modeling Project. This exploratory project suggested a prototype for a qualitative risk assessment methodology applicable to complex, partially observable dynamical systems driven by a number of interacting agents and affected by random factors. A dynamical system under consideration is simulated using an appropriate agent-based model. Part of the model's trajectories collapse. A desired methodology is expected to use available observations and register a tendency to collapse. This project implemented the proposed approach for a small-world network of agents repeatedly playing the Prisoner's Dilemma game. The network collapses whenever all the players defect. A learning algorithm that uses randomly observed groups of players to forecast collapse in the next round was suggested. A series of tests showed that learning improved the reliability of the forecasts.

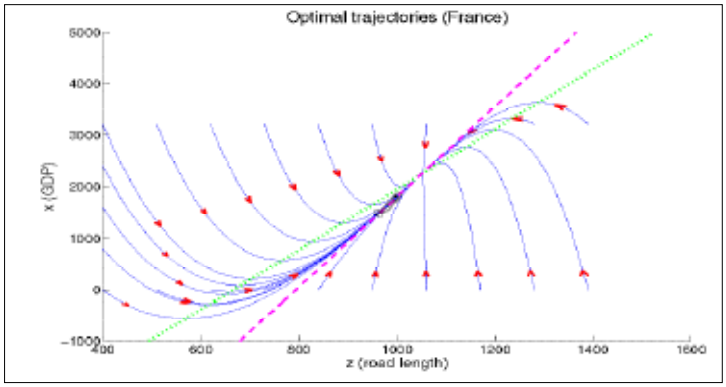


Figure 3. The optimal co-development of the GDP (shown on the vertical axis in their value of international dollars equivalent to the purchase parity of 1990) and capacity of the roads (shown on the horizontal axis in thousands of kilometers) in France. The green dotted line depicts the critical levels for GDP, above which the road infrastructure is unable to support GDP growth. The purple dotted line is the phase portrait of the optimal trajectory. The point, at which the two dotted lines intersect is the steady state attracting the optimal trajectory in the long run. The small black circles on the purple dotted line show real data for the period 1970–1994. It is seen that the economy is quite close to the steady state. If the technology for the construction of the roads does not change, future development will tend to slow down and lose stability in growth by infinitely approaching the critical level for GDP (the green dotted line). The blue curves show "virtual" optimal trajectories that start from "virtual" initial states. The red arrows show the directions of motion.

Environmental Applications: Methods for Coastal Area Management Project. This project addresses the issue of harmonizing feedback between the food industry and the environment. In 2008 research focused on the problem of how to minimize a negative impact on the environment by redistribution of pollution sources in a costal area. A one-dimensional setting, representing a case where the main current run is parallel to the coastline, was analyzed. An underlying model has the form of a second-order differential equation with a distributed control. It was stated that the problem is solvable and the structure of the solution was described.

Environmental Applications: Analysis of Moment-Based Models for Spatial Distribution of Species Project. In 2008 analysis of a moment-based model for a one-dimensional spatial distribution of a single-specie community was continued. A set of necessary conditions for the existence of a distribution of a given type was extended. The project involved researchers from DYN and the Evolution and Ecology (EEP) programs.

Environmental Applications: Consistency between Long-Term Climate Target and Short-Term Abatement Policy Project. The study addressed the issue of climate policy decision making. Because of the deep uncertainty of the climate system, it is almost impossible to plan abatement actions for a long period of time. The usual way is to design short-term actions that are consistent with a given climate target by maintaining the possibility of meeting the target in the long run. The project suggested a methodology for treating the consistency issue comprehensively. The so-called attainability and controllability domains used in control theory acted as a key tool. To illustrate the approach, a consistency analysis was carried out for a simplified DICE-94 climate–economy model. The analysis covered several long-term targets, several values for the climate sensitivity, and several scenarios for socioeconomic development. The project was carried out by DYN and FOR researchers.

Activities for 2009

In the area of ADS, DYN will further develop game-theoretic approaches and theory of infinite-horizon optimal control, with emphasis on applications in the areas of ECG and ENA. In the context of contribution to FCI, the ADS research agenda will include agent-based modeling and pattern recognition techniques.

In the area of ECG, DYN will develop applications of game-theoretic and control-theoretic approaches to multi-agent and multi-factor models of economic behavior. The issues of economic development under limited resources and growth under external random shocks will be addressed. It is planned to launch a regional case study, probably on India. A special effort will be devoted to consolidating IIASA's research on critical aspects of economic development and elaborating a general methodological framework for identifying key driving forces of economic growth.

In the area of FCI, DYN will extend studies of development of transportation infrastructures in the context of economic growth and launch a project on vulnerability analysis of energy infrastructures with applications to ecological networks and gas transportation systems. A basis for a general collapse assessment methodology involving agent-based modeling and pattern recognition techniques will be elaborated.

In the area of ENA, DYN will continue studies of coastal area management and studies with the EEP/DYN project on modeling spatial distribution of species. An effort in launching a project on integrated assessment of socioenvironmental systems is expected.

Scientific Recognition

Sergey Aseev

Editorships, memberships

- Deputy Editor-in-Chief, *Proceedings of the Steklov Mathematical Institute*
- Member, Technical Committee on Optimal Control, International Federation of Automatic Control

John Casti

Selected invited lectures

- "The Decline and Fall of Globalization," Vienna International University, Vienna, 20 March 2008
- *IIASA*. World Public Forum, Vienna, 14 March 2008.
- "The World of 2020," Annual Meeting of the European Futurists, Lucerne, Switzerland, 27 October 2008

Editorships

- Founding Editor, *Applied Mathematics and Computation*

Alexey Davydov

Selected invited lectures

- "Singularities of Averaged Optimization," International Conference on Nonlinear Analysis and Optimization Problems, Budva, Montenegro, 6–10 October 2008

Editorships

- Invited Editor, *Proceedings of the Steklov Institute of Mathematics*, **261** (2008)

Brian Fath

Selected invited lectures

- "Global Macro-Economic, Energy and Environmental Scenarios," Center for Energy, Environment, and Health Workshop, Roskilde, Denmark, 6–7 February 2008
- "Assessing Ecological Complexity: Goal Functions and Network Relations," Chesapeake Biological Lab, Solomons, Maryland, 1 October 2008
- "Ecological Goal Functions," Emergence of Novelties Workshop, Pacina, Italy, 9–15 October 2008.

Editorships, memberships

- Editor-in-Chief, *International Journal of Ecological Modelling*
- Member, Editorial Board, *International Journal of Design & Nature and Ecodynamics*
- Member, Board of Directors, International Environmental Modelling and Software Society
- Member, Scientific and Technical Working Group, Maryland Climate Change Commission, 2007–2008
- Member, Baltimore County Commission on Environmental Quality (CEQ)
- Member, Baltimore County Sustainability Network

Andrey Krasovskii

Selected invited lectures

- "Conjugation of Hamiltonian Systems in Optimal Control p\Problems," 17th IFAC World Congress, Seoul, Korea, 6–11 July 2008 (co-authored with A.Tarasyev)
- "Algorithms for Constructing Optimal Control in Nonlinear Problems with Infinite Horizon," World Congress of Nonlinear Analysts, WCNA'2008, Orlando FL, USA, 2–9 July 2008 (co-authored with A.Tarasyev)
- "Synthetic Optimal Trajectories in Economic Growth Modeling," International Seminar, Austrian Institute of Economic Research, 4 September 2008 (co-authored with R. Ayres and A. Tarasyev)

Editorships, memberships

- Member, Organizing Committee of a special plenary video-session between IIASA and Ural State Technical University (USTU-UPI), 3rd International Scientific Conference on Informational Mathematical Technologies in Economics, Ekaterinburg, Russia, 20–22 November 2008

Arkady Kryazhimskiy

Selected invited lectures

- "Krasovskii's Extremal Shift Control Principle and Its Applications." Plenary lecture, International Conference "Differential Equations and Topology," Moscow, 17–22 June 2008 (co-authored with Yu. S. Osipov)
- "Market Equilibrium: Applications to Emission Reduction and Economic Growth," Microeconomics Workshop
- "Dynamic Games in Economics," 4–5 December 2008, Rimini

Editorships, memberships

- Editorial Board Member, *Journal of Computational Mathematics and Mathematical Physics*
- Associate Editor, *International Game Theory Review*
- Member, Program Committee, International Conference "Differential Equations and Topology" dedicated to the Centennial Anniversary of L. S. Pontryagin, Moscow, 17–22 June 2008
- Chairman of the Section "Optimal Control and Differential Games" of the International Conference "Differential Equations and Topology," dedicated to the Centennial Anniversary of L. S. Pontryagin, Moscow, 17–22 June 2008
- Member, Russian Academy of Sciences

Yaroslav Minullin

Selected invited lectures

- "Vulnerability and Resilience of Energy Infrastructures," Roundtable: World Energy Demand and Price Setting Analysis, Padova, Italy, 21–22 April 2008
- "Energy Security from a Systems-Analytical Perspective," Advanced Research Workshop "Energy Security in the Black Sea Area–Critical Infrastructures Protection and System of Systems Engineering," Bucharest, Romania, 19–23 October 2008
- "Competition and Energy Security: Is There a Trade-Off?" 3rd Energy Workshop, Budapest, Hungary, 27–29 October 2008

Tapio Palokangas

Editorships, memberships

- Guest Editor, *Applied Mathematics and Computation*, Special Issue, Proceedings of the IIASA/IFAC Workshop "New Approaches in Dynamic Optimization to Assessment of Economic and Environmental Systems," held at IIASA, 5–7 December 2006
- Co-Chairman, Program Committee, IIASA Symposium "Applications of Dynamic Systems to Economic Growth with Environment," held at IIASA, 7–8 November 2008
- Member, Program Committee, International Federation of Automatic Control (IFAC), Workshop on Control Applications of Optimization (CAO '09), University of Jyväskylä, Finland, May 2009

Alexander Tarasyev

Selected invited lectures

- "Conjugation of Hamiltonian Systems in Optimal Control Problems," 17th IFAC World Congress, Seoul, Republic of Korea, 6–11 July 2008 (co-authored with A.Krasovskii)
- "Algorithms for Constructing Optimal Control in Nonlinear Problems with Infinite Horizon," World Congress of Nonlinear Analysts, WCNA 2008, Orlando FL, USA, 2–9 July 2008 (co-authored with A. Krasovskii)
- "Synthetic Optimal Trajectories in Economic Growth Modeling," International Seminar, Austrian Institute of Economic Research, 4 September 2008 (co-authored with R. Ayres and A. Krasovskii)

Editorships, memberships

- Chairman, Technical Committee on Optimal Control, International Federation of Automatic Control
- Guest Editor, *Applied Mathematics and Computation,* Special Issue, Proceedings of the IIASA/IFAC Workshop "New Approaches in Dynamic Optimization to Assessment of Economic and Environmental Systems," held at IIASA, 5–7 December 2006
- Co-Chairman, Program Committee, IIASA Symposium, "Applications of Dynamic Systems to Economic Growth with Environment," held at IIASA, 7–8 November 2008
- Member, Organizing Committee of a special plenary video-session between IIASA and Ural State Technical University (USTU-UPI), 3rd International Scientific Conference on Informational Mathematical Technologies in Economics, Ekaterinburg, Russia, 20–22 November 2008
- Chairman, Program Committee, International Federation of Automatic Control (IFAC), Workshop on Control Applications of Optimization (CAO '09), University of Jyväskylä, Finland, May 2009

Transition to New Technologies Program

Arnulf Grubler (Acting Program Leader)
gruebler@iiasa.ac.at

Objectives

The objective of the Transitions to New Technologies (TNT) Program is to analyze the patterns and drivers of technological change across sectors, over time, and across space. In terms of systems hierarchy, technological change arises from the spatial and temporal diffusion of individual innovations all the way up to the emergence of new technological combinations that could fundamentally redefine products, services, and even entire markets. TNT's research aims for an improved empirical understanding that feeds into new modeling approaches of technological change with an emphasis on the treatment of technological uncertainty, spatial heterogeneity, and assessments of the potential economic and societal impacts that could result from pervasive diffusion and adoption of new technologies. The research focuses particularly on new communication, information, mobility, and energy and climate-friendly technologies; it aims to maximize synergies and cooperation with other IIASA research programs, in particular Energy (ENE), the Global Energy Assessment (GEA), and the Greenhouse Gas Initiative (GGI). Research is based on a blend of basic and applied research. The basic research includes conceptual as well as theoretical modeling work inspired by empirical case studies. The applied research informs technology policy choices through sectoral case studies, uncertainty and scenario robustness analysis, and inputs to major international assessments.

Among the highlights of TNT activities in 2008 were two workshops on innovative topics. One was a **workshop on methane hydrates** co-organized with the Global Carbon Project (GCP), an activity of the International Council of Science (ICSU) which featured prominently in the journal *Science*. The other was a **workshop on technologies to combat global warming**, co-organized with Bill Nordhaus from Yale University.

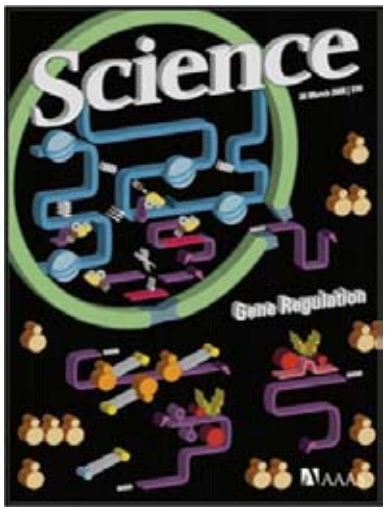


Figure 1. Cover of *Science* **319**(5871):1753, which prominently featured a report on the workshop on Vulnerability of Methane Hydrates, held at IIASA in March 2008.

Under the auspices of IIASA's **Global Energy Assessment**, TNT was entrusted to coordinate work on two **knowledge modules**, **one** on **urbanization** and the other on **technology innovation policy**. The year 2008 saw significant progress with altogether four GEA lead author meetings convened by TNT: two at IIASA and one each at the United Nations Development Programme (UNDP) and Harvard University in the United States (USA). The first two papers reporting on the **novel agent-based model of technological complexity** developed by TNT researchers were also published in 2008. Finally, in 2008 efforts were intensified in the **modeling of spatial phenomena** as inputs to technology diffusion potential assessments conducted within TNT; these also serve equally as a basis for developing spatially explicit scenarios of urbanization, air pollution, and health impact exposures developed jointly with the GEA, ENE, the Air Pollution and Economic Development (APD) Program, and the Greenhouse Gas Initiative.

Scientific Achievements in 2008

Workshops

TNT's strong emphasis on international collaborative networks confers a particular comparative advantage on the TNT Program in terms of organizing high-level workshops on innovative topics and exciting new technology fields. Two such workshops were convened in 2008.

The first, co-organized with and co-funded by the Global Carbon Project, was a workshop on **Vulnerability of Methane Hydrates**, held at IIASA on 13–14 March 2008. Methane hydrates—methane (natural gas) trapped in the lattice structure of ice molecules ("burning ice")—are receiving increased attention both for their critical role in past and future climates and as an exotic and potentially vast energy resource. The workshop discussed: 1) both the abundance of methane hydrate deposits and the uncertainties emerging from latest assessments; 2) the role of methane hydrates in paleo- as well as in future climates; and 3) the prospects and technological options and challenges for extracting methane hydrates in an environmentally sound manner. IIASA scientists **Volker Krey**, **Arnulf Grubler**, and **Nebojsa Nakicenovic** presented a comprehensive model sensitivity analysis of the potential of methane hydrates as a function of extraction costs, resource potentials, climate constraints, and the availability of complementary technologies and infrastructures. Perhaps the most significant consensus emerging at the meeting was the fact that both scientists and industry representatives agreed on the perspective that the question is not *whether* industry will exploit hydrates but rather *how soon*, with industry experts projecting a potential $200 billion industry within the next two decades. The workshop was prominently featured in the journal *Science* **319**(5871):1753 (*Figure 1*), which concluded: "More meetings like these are clearly needed."

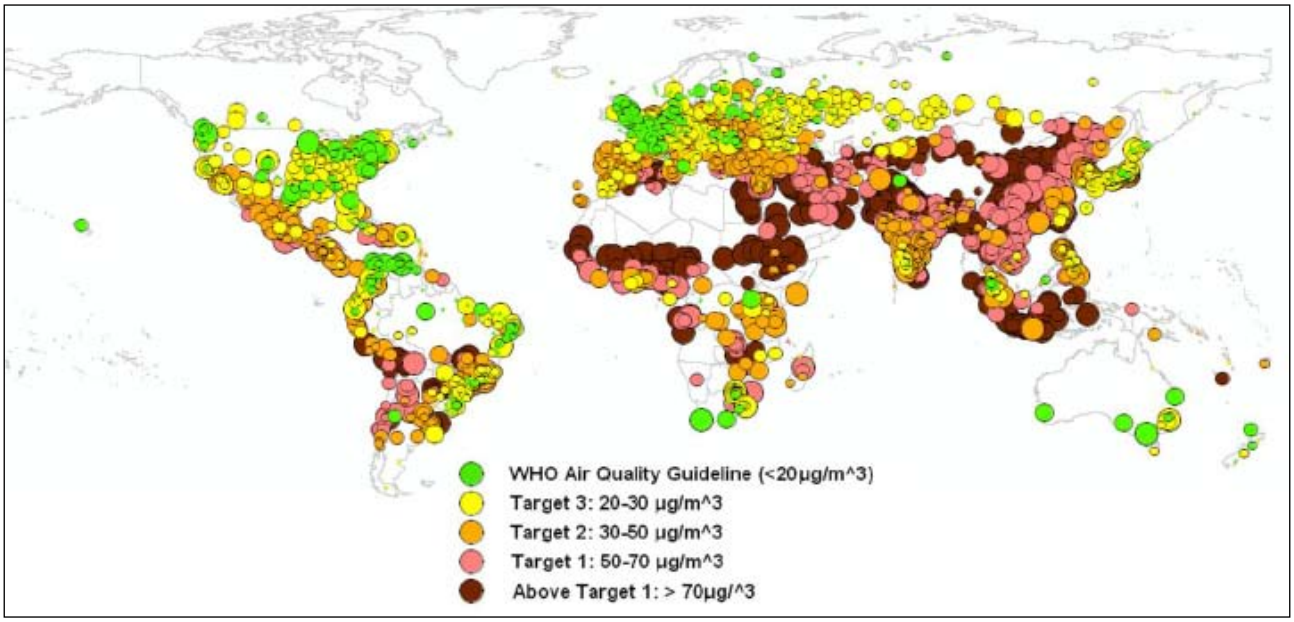


Figure 2. Human health risk exposure (pollution concentration times population at risk) map for PM 10 particulates from urban air pollution, based on World Bank estimated for 3,200 cities worldwide. Risk exposures are differentiated by World Health Organization (WHO) air quality guidelines. From the 3200 cities with some 2 billion inhabitants, only 450 with 165 million people meet WHO air quality guidelines. Eight hundred cities with close to 800 million people are above even the highest WHO air pollution standard. As such the Figure illustrates the importance of broad perspectives in assessing the diffusion potentials of new technologies. Graphic courtesy of Christopher Doll.

A second workshop, co-organized with Bill Nordhaus from Yale University and funded by the Kauffman Foundation on **The Economics of Technologies to Combat Global Warming** was held in Snowmass, Colorado, on 3–4 August 2008. The workshop was actually a preparatory meeting for a larger workshop on the same topic to be convened in 2009, either at IIASA or again in Snowmass. Participants discussed the main research priorities required to gain a deeper understanding of the availability of climate-friendly technologies, their characteristics, and the policy mechanisms needed for their development and ultimate market deployment. Also discussed was how to integrate these new insights into economic policy models embracing an induced technological change (ITC) perspective which has traditionally been a hallmark of TNT research.

Global Energy Assessment

Within the context of the Global Energy Assessment (see GEA and ENE progress reports), TNT has received the distinction of coordinating two knowledge modules (to be chapters of the published report), with Arnulf Grubler serving as Convening Lead Author: one on urbanization and the second on technology innovation policy. By assembling a distinguished group of international scholars the Program was able to make a head's start on this major assessment, organizing altogether four Lead Author meetings: two at IIASA and two in the USA.

The importance of **urbanization** as a driver for global change and that of cities as crystallizing nodes for technological innovation and adoption is becoming increasingly recognized. According to UN estimates mankind is currently passing a historical threshold, with 50 percent of world population living in cities. As TNT research performed by Grubler and **Vadim Chirkov** indicates, this threshold has already been passed significantly for other global change or technology indicators. For instance TNT estimates indicate that urban areas are generating/consuming about 80 percent of global GDP, that they account for about two-thirds of global final energy use, and that they host an astonishing 96 percent of all Internet routers. In other words, cities form the backbone of the global Internet infrastructure (and also frame its corresponding vulnerability). In turn, cities represent not only considerable environmental challenges (see *Figure 2* based on the research of IIASA postdoctoral fellow **Christoper Doll**) but also vast diffusion potentials for the adoption of environmentally friendly technologies. TNT's urbanization focus therefore represents a logical step in an improved understanding of spatial heterogeneity in technology development, choice, and deployment. One of the Lead Author meetings of GEA's urbanization chapter was held at the United Nations Development Programme (UNDP) in New York at the invitation of Minoru Takada of UNDP's Sustainable Energy Programme. The meeting provided an opportunity to brief UNDP staff on the overall GEA assessment, the work performed for the urbanization chapter, and the policy implications of a rapidly urbanizing world.

TNT also coordinates the GEA knowledge module on **technology innovation policy**, reflecting recognition of the many important contributions made by TNT researchers in the domain of technology and innovation studies. The knowledge module has two thematic foci. The first is to gain a deeper theoretical and empirical understanding of the factors underlying improvements and cost reductions in new energy technologies (*Figure 3*). This look inside the "black box" of so-

called learning or experience-curve phenomena is especially needed because of the policy pitfalls of naïve demand–pull technological innovation perspectives: these are encapsulated in concepts like technology "cost buy downs," which ignore the importance of R&D and classical economies of scale with their distinct and different drivers, policy leverages, not forgetting boundary conditions and constraints. One Lead Author meeting was held at Harvard University, where the chapter authors exchanged with **John Holdren**, who in the meantime has been nominated **Science Advisor** of the Obama Administration. The second focus of the GEA innovation chapter is on **technology policies**, where successes as well as failures in an international and technology comparative context are assessed in order to respond to the growing demand from a wide range of policy constituencies, particularly in the areas of energy security, sustainable development, and climate protection.

It is crucial to recognize the important linkages that exist between the two topics of urbanization and technology, which are the subject of TNT's coordinating role within GEA. Cities are well known as core innovation centers and early adopters of new technologies. As other example of these linkages, consider that the energy demand densities of any large urban agglomeration are high enough to exceed the energy flows that can be harnessed with renewable energies locally. For instance, estimates indicate that in order to supply London with renewable energies based on current technologies and under European conditions, one would need an area twice the size of the entire United Kingdom. The concept of matching energy demand and supply densities thus has important implications not only for technology and infrastructure design but equally for sustainability science, where new concepts and criteria are needed to define urban sustainability across interacting spatial scales that may not be in geographical proximity to each other.

Describing and Modeling Spatial Heterogeneity

The strong focus on the spatially heterogeneous dimensions of technologies is not only an important pioneering research field but also constitutes an important service that TNT is able to render to other research programs at IIASA, furthering in-house collaboration. In 2008 extensive methodological and empirical work was devoted to GIS-based downscaling of a range of socioeconomic drivers, such as urbanization or energy use, as well as to the development of spatially explicit models and scenarios. For instance, the energy and emissions downscaling work provides an important input to the new **Reference Concentration Pathways** developed by the Integrated Assessment Modeling Consortium (IAMC) for the Intergovernmental Panel on Climate Change (IPCC) (see ENE Progress Report); it is also at the core of a new in-house collaboration at IIASA between TNT, ENE, and APD for assessing the health benefits of the diffusion of climate-friendly technologies within the framework of the GEA scenario activity focusing on sustainability transition pathways and their policy implications.

Software and Database Development

An integral part of the service function that TNT aims to provide to other IIASA research programs and to the wider scien-

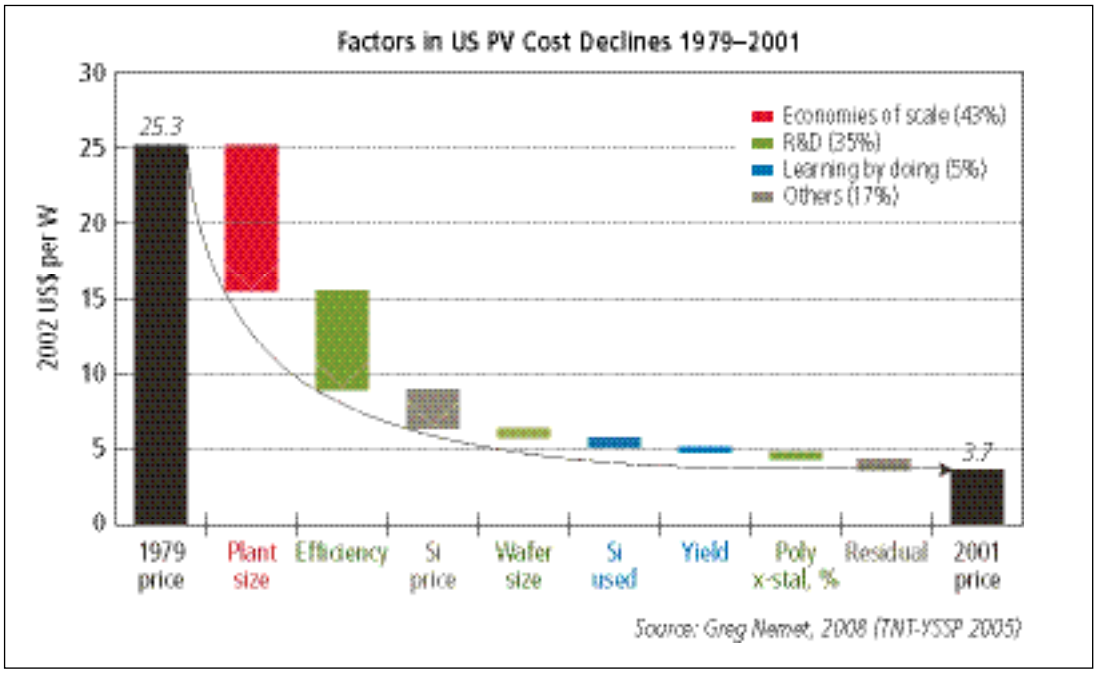


Figure 3. A look into the "black box" of technology dynamics. Factors in cost reductions of US photovoltaics (PVs) between 1979 and 2001, when costs declined from 25.3 to 3.7 $/W. Economies of scale in manufacturing and technological change arising from R&D emerge as dominant factors in the impressive cost reductions of PVs. Conversely, classical "learning-by-doing" effects are comparatively small, even if aggregate cost trends appear to follow the functional form of a correlation between cost improvements and cumulative industry output. Source: Gregory Nemet, 2007 (TNT-YSSP 2004, continuing collaborator, and GEA Lead Author).

tific community are online databases and Web-based software and models. **Peter Kolp** continued the successful software and database development that, next to scientific publications, has become a hallmark of TNT's "tangible" research outputs. Building on the extremely successful model of an interactive Web-based database that documents all salient inputs and outputs of the GGI scenarios (see http://www.iiasa.ac.at/web-apps/ggi/GgiDb/ and Progress Report 2007), a new Web-based database software and structure for the new IPCC RCP scenarios was developed in 2008. The database is expected to go online in 2009. The fact that the entire integrated assessment modeling community involved in the new IPCC scenarios (see the ENE Progress Report) entrusted IIASA and TNT with this task represents a recognition of the usefulness of the new standards with respect to the reproducibility and documentation of model-based decision support set by TNT software products. As such, TNT not only studies new technologies; it also **develops** new ones to further transparency and documentation of model results that are at the very core of the science–policy interface in responding to global change.

Agent-Based Modeling

In 2008 an important milestone in the research on technological complexity based on a novel approach of agent-based modeling was achieved with the first two papers being published. In the papers, **Tieju Ma**, Grubler, Nakicenovic, and IIASA Institute Scholar, **Brian Arthur,** not only discuss the methodological underpinnings of this new evolutionary perspective on the long-term evolution of technological complexity but also derive a number of the policy-relevant conclusions that emerged from this comparatively simple, stylized model. Foremost is the trade-off between maintaining desirable technological diversity and equally desirable improvements in the economics of new technologies due to standardization and increasing returns to adoption, which, however, tend to crowd out diversity. Second, is the recognition of the longevity of technology systems, arising from technological interrelatedness and clustering effects; this calls for novel policy mechanisms for the retiring of existing technology vintages, if indeed pervasive system changes need to be implemented over time scales commensurate with the urgency of the climate protection challenge. Finally, an interesting finding emerging from hundreds of model simulations is the identification of an endogenous mechanism that can replicate the historical trend toward energy "decarbonization" (i.e., a relative decline in the carbon emissions intensity of the global energy system), which to date has defied modeling attempts by mainstream climate policy models (see *Figure 4*).

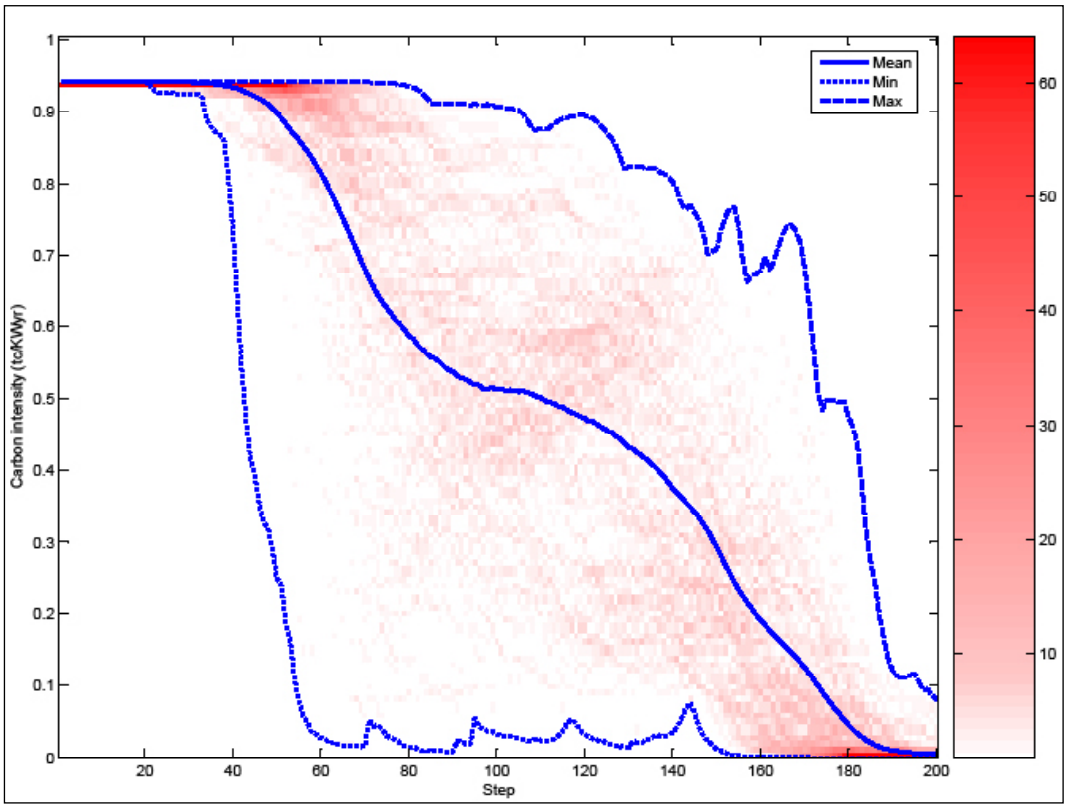


Figure 4. Evolution of the pollution intensity (carbon emissions per unit of energy) over 200 simulation time steps (years) and across 200 simulations (min/max, mean, and dispersion of simulation runs with density denoted by color shading) of an agent-based model of technological complexity. The model suggests an endogenous mechanism to replicate the historical pervasive trend toward "decarbonization," that to date has defied attempts at endogenous modeling with conventional climate policy models. Source: Ma, Grubler, Nakicenovic, and Arthur, IIASA IR-08-021.

Networking and Policy Impact

A precondition for policy relevance is the combination of pertinent new research insights with a clear communication strategy for the insights gained by in-house and collaborative research and via international assessments. TNT's communication strategy focuses on harnessing the weight accorded to policy briefs from major international assessment activities such as the IPCC or GEA, serving on a wide range of science and technology advisory panels (see listing below) in order to assist in defining the science and policy agendas, and on participating in high-level forums framing the policy discourse on major global challenges. Quite naturally, this task resides with the senior members of TNT's scientific staff, most notably Nakicenovic.

As examples of this science and policy outreach, which comprised altogether some 67 external presentations (see listing below), three high-level events/activities are *pars pro toto* mentioned here. Nakicenovic serves on the advisory board for the (World Bank's) **World Development Report 2010**, with its focus on energy and climate, two core research topics of IIASA to which TNT actively contributes. TNT's research in the field of sustainability science (a *Science* paper co-authored by Grubler ranks among the top 249 articles in SCOPUS citation statistics of all 126 indexed TNT publications) was recognized by an invitation to Nakicenovic to participate in two roundtables/expert panels convened by the **US National Science Foundation (NSF)** on sustainable energy and on research priorities in sustainable development to help to define NSF's research priorities in these fields. Nakicenovic was also invited to participate and deliver a presentation in a meeting on Global Warming Issues convened by the Japan Science Council on the occasion of the G8 summit in **Japan**.

The overall TNT in-house research effort amounted to 45 scientific person-months in 2008. Altogether, TNT Program members served on 22 external Advisory Boards and Steering Committees, delivered some 67 lectures, served on the Editorial Boards of 9 journals, and published 15 peer-reviewed papers in 2008.

Activities for 2009

TNT Research in 2009 will focus primarily in three areas:

1. A full-scale Workshop on **The Economics of Technologies to Combat Global Warming** is planned for August 2009 either at IIASA or in Snowmass, co-organized with Bill Nordhaus of Yale University. Building on the preparatory workshop held in 2008, the meeting will serve to discuss in detail a series of commissioned papers that deal with theory, models, and empirical aspects of climate-friendly technologies, as well as their inducement mechanisms and corresponding policies. The edited final papers will be published in the form of a Special Issue of a leading journal in the field.
2. Work within the two knowledge modules on **urbanization** and **technology innovation policy** of the **Global Energy Assessment** will constitute the main thrust of TNT's activities in 2009. A first full draft of the chapter text and supporting material for the two knowledge modules, respectively, will be completed and forwarded for external peer review. In addition, a series of working papers reporting on technology case studies performed within the GEA group of Lead Authors will be initiated; this is slated for publication in 2010. Within the urbanization knowledge module, spatially explicit scenarios of urbanization will be developed in cooperation with the GEA scenario knowledge module and used, inter alia, for an assessment of the health implications of the diffusion of climate-friendly technologies and their corresponding secondary benefits in terms of reduced urban air pollution. The latter will constitute a joint collaborative effort between TNT, ENE, APD, and GEA.
3. Finally, in-house basic research will focus on further development of the agent-based modeling approach to technological complexity. A new generation of the model will be developed with a one order of magnitude higher technological resolution focusing on technology (sub-)components as constituting model entities. The objective of this research is to enable more light to be shed on the complex issue of technology spillovers that are likely to characterize a wide range of technology clusters in the twenty-first century, such as the convergence of ITC and physical transport and energy infrastructures.

TNT Scientific Recognition

See joint ENE/GEA/TNT list.

Energy Program

Keywan Riahi (Acting Program Leader)
riahi@iiasa.ac.at

Objectives

The central research goal of the Energy (ENE) Program is to provide overarching scientific and strategic analysis to permit a better understanding of the dynamics of future energy transitions, their main driving forces and enabling factors, and their consequences for the social, economic, and environmental dimensions of human wellbeing. Decisions made today and in the near future are sowing the seeds that will determine which of the range of alternative energy development paths are followed over the long term, which paths are promoted, and which are hindered. Given the interactions between energy and almost all economic and social activities, a better understanding of the long-term implications of alternative energy policies and related investments and technological developments are imperative now.

The activities of the ENE Program in 2008 were geared toward addressing the most salient challenges confronting the global energy system by pursuing three main areas of research with the objectives of (1) conducting policy-relevant scenario analysis with the focus on identifying the main energy transitions required to avoid "dangerous interference with the climate system"; (2) facilitating coordination among the main scientific communities for the development of the next generation of integrated climate scenarios for the Intergovernmental Panel on Climate Change (IPCC); (3) developing new modeling approaches with explicit representation of the main determinants of energy poverty in order to identify effective policy mechanisms for "connecting" the poor; (4) continuing the development of the stochastic energy modeling framework for robust decision making under uncertainty and risks.

Scientific Achievements/Projects in 2008

Intergovernmental Panel on Climate Change (IPCC)

The year 2008 constituted an important milestone for the Energy Program's research activities in the field of climate change. Most notable was the publication of the **Synthesis Report** of the IPCC, with ENE staff member Keywan Riahi serving as an author and member of the core writing team. The Synthesis Report (*Figure 1*) with its "Summary for Policymakers" is the final part of the IPCC's Fourth Assessment Report and aims to integrate the main findings of the Assessment for decision makers, governments, and the public and private hand. The release of the Synthesis Report thus also reflects the Program's cumulative contribution to the IPCC's Fourth Assessment Report over the recent years, with three ENE scientists as Coordinating Lead Author (**Nebojsa Nakicenovic**), Lead Author (**Keywan Riahi)**, and Contributing Author (**Shilpa Rao**). A distinguishing feature of the Synthesis Report is its comprehensiveness in the sense that it brings together not only information on observed changes in climate, their drivers, and their effects on natural and human systems, but also future risks of potentially irreversible impacts and the necessary response in terms of greenhouse gas emissions mitigation and adaptation.

While the main findings of the Synthesis Report have received widespread attention in the press and political negotiations, they also identify critical gaps in knowledge and important areas of future research. This concerns in particular the need for a set of new integrated climate scenarios for the full range of future greenhouse gas emissions, including extreme low contraction scenarios with stringent climate policies. In 2008 the ENE Program was actively involved in the multi-stakeholder process to shape the development of these new scenarios for the IPCC in three ways:

First, from an organizational perspective, the ENE Program in 2008 continued to play an important role in the planning and coordination of research tasks across the main international climate research communities. Central in this process is the **Integrated Assessment Modeling Consortium (IAMC)**, established in 2007 under the leadership of IIASA-ENE, the Stanford-based Energy Modeling Forum (EMF) of the United States, and the National Institute of Environmental Studies (NIES) of Japan. An IAMC workshop, involving more than two dozen international modeling teams, was hosted by the ENE Program in Baden, Austria, in September 2008 to review scenario development progress and coordinate the next stages of research. Among other things, the IAMC established a review panel, on which ENE staff member Nebojsa Nakicenovic is now serving. The review panel will act as a scientific consultative body to advise the IPCC Steering Committee on New Emissions Scenarios regarding which greenhouse gas stabilization level should be adopted for the lowest attainable scenario. This decision will be critically important for policy decisions for both adaptation and mitigation, as it will help to

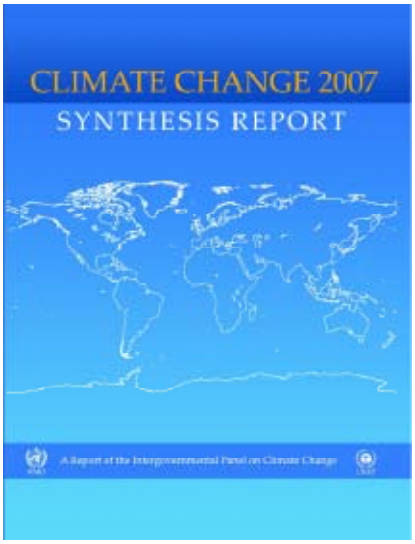


Figure 1. Cover of the AR4 IPCC Synthesis Report, released in 2008.

understand the benefits of the most stringent climate policies for the attainment of extreme low stabilization levels as well as the remaining risk of unavoidable impacts.

Second, and from a scientific perspective, substantial efforts were made in 2008 toward developing spatially explicit emissions and land-cover-change projections of the so-called **Representative Concentration Pathways (RCPs)**, which will form the analytical backbone of the climate change projections of the **IPCC's Fifth Assessment Report**. The RCPs build on the four integrated assessment scenarios from the literature. The A2r scenario, developed by the ENE Program in collaboration with the Greenhouse Gas Initiative (GGI), has been selected as the highest concentration pathway. The RCPs will be the first projections of their kind, with full spatial coverage of land-cover changes as well as pollutant emissions and greenhouse gases; they will include historical projections from pre-industrial times and smooth transitions up to the year 2300. Novel features from the methodological side include the rule-based downscaling of pollutant emissions projections, taking into consideration spatial pollution-control policies based on dynamic maps of human exposure. The development of the RCP scenarios has also fostered substantial cross-program collaborations within IIASA and painstaking exchanges between ENE and the Land Use Change and Agriculture (LUC), Forestry (FOR), and Air Pollution and Economic Development (APD) programs. The fine spatial resolution of the RCP scenarios will permit climate modeling teams within the IPCC to better cover the greenhouse gas implications of land-cover changes, including, for example, the assessment of carbon cycle feedbacks as well as improved estimations of the consequences of albedo changes for the local climate. In addition, the spatial information from the RCPs is important for future impact assessments.

Third, a Web-based data repository was developed in collaboration with Transition to New Technologies (TNT) for the central storage of the RCP data. Presently, the RCP database (*Figure 2*) serves as an internal working environment for the four IAM modeling teams to review consistency and integrity of the RCP data. Final RCP datasets are expected to be completed in 2009, when the database will become publicly accessible. The RCP data dissemination activity through the IIASA Web

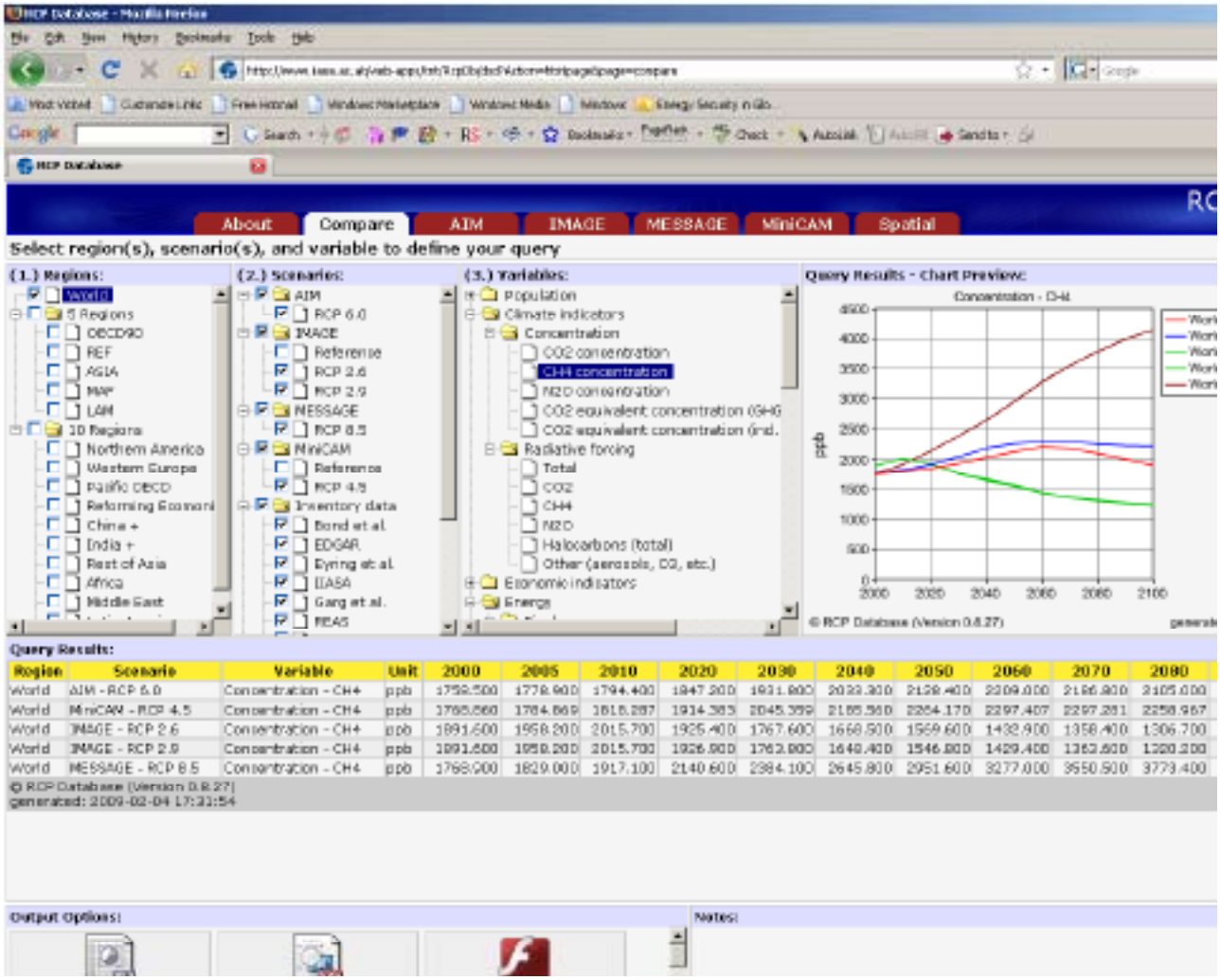


Figure 2. Snapshot of the interactive IIASA scenario database. The database is planned to serve as a central repository and data-dissemination tool of the "Reference Concentration Pathways," which will be used for the climate simulations of the Fifth IPCC Assessment Report.

page is providing a unique service to the main climate research communities and is thus also expected to generate significant interest in IIASA's climate-related work beyond the RCPs.

Climate Thresholds and Extreme Low Concentration Targets

In addition to the aforementioned IPCC-related research and coordination activities, 2008 was also an important year with respect to the finalization of the analysis of **interim climate policy targets for the mid-century**. These targets are proposed as a way to guide policy over the next several decades in the absence of agreement on a long-term goal, so that a range of options can be preserved for the choice that is eventually made. Such an approach would allow time for scientific uncertainties about long-term outcomes to be narrowed and political disagreements over the definition of "dangerous anthropogenic interference" to be bridged before a long-term target is adopted. One key result of the study conducted in collaboration with the Population and Climate Change (PCC) Program is that for each long-term climate change outcome, there is a critical threshold of mid-century conditions, above which achieving the long-term goal becomes infeasible (*Figure 3*). For example, if it is desirable to have at least a 50 percent chance of limiting warming to 2°C over the course of the century, we find that carbon dioxide (CO_2) emissions in 2050 cannot be above about 7 billion tons of carbon. A second key result is that in addition to this infeasibility threshold, it is possible to identify mid-century conditions that would preserve long-term options at least cost. For example, in the case of maintaining a 50 percent chance of remaining below 2°C warming, emissions of about 6 billion tons of carbon in 2050 minimizes costs. Mid-century targets can be equally well expressed in terms of the fraction of global energy in 2050 that must be obtained from zero-carbon sources. The analysis indicates that mid-century targets could serve as useful policy guideposts, providing a framework for linking uncertain long-term climate goals with the shorter-term actions that may be necessary over the next few decades to achieve them. The study and its main findings will be presented at the international scientific congress on "Climate Change: Global Risks, Challenges and Decisions," held 10–12 March 2009, in Copenhagen, Denmark, which is a preparatory event for the 15th Conference of the Parties (COP 15) to the United Nations Framework Convention on Climate Change (UNFCCC) in late 2009.

As part of its climate-related research activities ENE also completed in 2008 a European Union funded study on the **attainability of extreme low greenhouse gas concentration scenarios**. The study complements the mid-century analysis presented above. The focus of the analysis is toward assessing the flexibility of the greenhouse gas (GHG) emissions pathway with regard to alternative timing of mitigation and the robustness of the scenarios in the face of possible technological uncertainties. Model runs are performed which explore the feasibility of reaching a 450 ppm CO-equivalent concentration level, which would correspond to limiting CO_2-only concentrations to below today's levels in the long term. The attainability of such low targets is systematically examined with respect to key uncertainties, including alternative baseline development pathways, availability of different technologies, emissions of bioenergy, and the impacts of forestry and land use assumptions. A key finding from the study is that the attainability of low concentration targets is critically dependent on the successful implementation globally of ambitious efficiency and demand-side management policies beyond historical rates. In addition, the study finds that limiting CO_2 concentrations to about today's level poses enormous challenges and will require fundamental restructuring of the energy system, including in particular the large-scale deployment of "negative emissions technologies" in the long term.

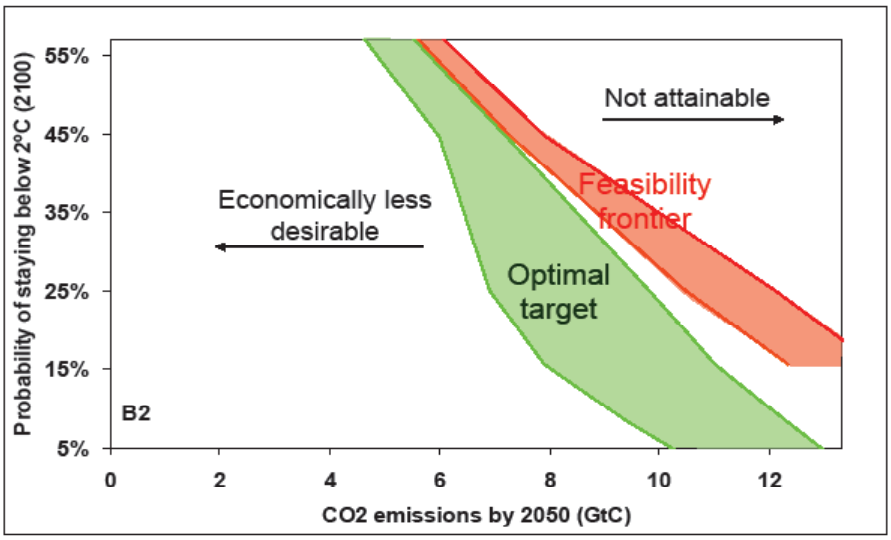


Figure 3. Feasibility of long-term global average temperature outcomes as a function of mid-century CO_2 emissions. Red area marks division between feasible (to the left) and infeasible (to the right) combinations of 2050 emissions levels and likelihoods of remaining below 2°C of warming by 2100. Green area marks combinations that minimize total mitigation costs. (Source: B. O'Neill, K. Riahi, I. Keppo, forthcoming)

Modeling of Uncertainty and Energy Poverty

Two ENE core research topics with a methodological focus in 2008 comprised the areas of d**ecision making under uncertainty** and the **modeling of energy access and poverty eradication**:

The development of the stochastic systems engineering model, initiated in 2007, was continued in 2008. As a result of feedback from presentations at several workshops, the model was continuously improved and adapted to become available as an online, open-source tool in 2009. A recent methodological extension is the incorporation of increasing returns to scale through **uncertain endogenous technological change**. The appropriate treatment of technological change is one of the most complex and salient questions remaining in climate change policy modeling. Treating learning of new emerging technologies as uncertain provides a more realistic representation of the path-dependency of technological change. The risks inherent in these uncertainties have a major impact on today's decisions that eventually shape the future landscape of energy systems. With uncertain technological change, a more prudent intermediate path of energy technology penetration is charted and a more diversified technological portfolio is revealed than in deterministic approaches. This model development benefited from a Young Scientists Summer Program (YSSP) project in 2008.

Improving access to affordable modern energy is deemed to be a critical factor in improving living standards in the developing world. Particularly rural households in India rely mostly on traditional biomass to satisfy their basic energy needs, and this has adverse effects on human health not only through indoor air pollution but also in terms of land degradation and decreased labor productivity. In 2008 collaborative work between the ENE and the PCC Program focused on the development of a new generic modeling approach that aims to identify strategies for energy poverty eradication in India. The modeling analysis covers a number of novel features which permits the assessment of the main characteristics of the fuel consumption of the poorest. A major step forward in energy poverty modeling is, in particular, explicit representation of the main determinants of urban and rural energy fuel choice, including the effect of income distributions and capital scarcity on energy use as well as the traditionally more intangible factors such as "inconvenience costs" or private discount rates. A first prototype model was developed and applied in 2008 to explore how different policy mechanisms such as fuel subsidies and micro financing can enhance the diffusion of clean and affordable energy in India. Final results from the study are planned to be part of the ENE Program's scientific contribution to the Global Energy Assessment (for details about GEA, see GEA Progress Report 2008).

Networking and Policy Impact

Beyond the research and coordination activities highlighted above, ENE in 2008 continued its collaboration with the Tokyo Electric Power Company on the economic and environmental implications of rapid electrification, and with the World Bank on greenhouse gas emissions mitigation. Strategic collaborations were complemented by networking activities. Most notably, Nebojsa Nakicenovic participated in the Hong Kong roundtable convened by Sir Nicholaus Stern, the objective of which was to develop a "global deal" to be considered at the UNFCC COP 15 meeting in Copenhagen in 2009. Similarly, Nakicenovic was invited in 2008 by Dr. Franz Fischler, Chairman of Ecosocial Forum Europe and Former Commissioner for Agriculture, Rural Development and Fisheries, to give a presentation at the European Parliament's conference to develop a "global contract." Against the background of the ongoing negotiations for a post-2012 agreement on climate change (COP 14 in Poznan in December 2008), the conference sent a widely recognized signal and issued a memorandum identifying equitable targets for industrialized and developing countries to combat climate change. As a member of the Advisory Board of the OMV Future Energy Fund, Nakicenovic was also instrumental in identifying strategic investments for the Fund in innovative renewable energy solutions and greenhouse gas emissions mitigation. Last but not least, ENE Program members continued their networking activities within the Stanford-based Energy Modeling Forum (EMF), and ENE staff member Volker Krey was invited in 2008 to serve as a Lead Author for the IPCC Special Report on Renewables.

The overall ENE in-house research effort amounted to 70 scientific person-months in 2008. Altogether, ENE Program members served on 21 external Advisory Boards and Steering Committees, delivered some 70 lectures, served on the Editorial Boards of 5 journals, and published 10 peer-reviewed papers in 2008.

2009 Activities

ENE research activities in 2009 will primarily focus on three areas:

1. **Finalizing the development and provision of detailed scenario information to the climate modeling Community**. This activity will continue to be a central part of the IAMC Consortium activities and will facilitate the use of the IIASA A2r scenario as one of the four Reference Concentration Pathways. In addition, the final release of the RCP-database hosted by IIASA-ENE is planned in 2009, which will assure effective dissemination of the scenario results to the broader research community.
2. **Providing scientific input to the Global Energy Assessment (GEA) and coordinating GEA's knowledge module on Scenarios**. The objective of GEA scenarios will be twofold: 1) to provide a quantitative and qualitative framework for identifying specific measures and policies for the transition to a sustainable energy system, and 2) to facilitate integration and assure consistency of diverse energy issues discussed across the different GEA Knowledge Modules.
3. **Continuing with the development and improvement of the modeling methodologies in the area of energy access and uncertainty**. The development of the former will focus on the modification of the software package in order to make the ENE stochastic modeling framework available as an online, open-source tool for the wider community of energy analysts. The methodology development in the area of energy access will focus on improvements and

integration of the simple prototype model of energy access into the systems engineering model MESSAGE. The integration of the two modeling frameworks will result in a novel tool, which would account for both supply-side infrastructure constraints and demand-side implementation barriers, and thus help to identify holistic response strategies to energy poverty.

ENE Scientific Recognition
See joint ENE/GEA/TNT list.

Global Energy Assessment

Nebojsa Nakicenovic (Director)
naki@iiasa.ac.at

Objectives

The Global Energy Assessment (GEA) is a major initiative organized by IIASA in late 2005 and formally launched in 2007 to help decision makers address the challenges of providing energy services for sustainable development, while ameliorating existing and emerging threats associated with: 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 responds directly to this need and, by doing so, will go well beyond existing authoritative studies on energy-related issues, which have generally provided only limited integrated analysis of the range of potentially competing energy objectives. This unique approach will ensure that the GEA plays a critical role in reducing the risk that energy-related decision making and implementation by governments, investors, enterprises, and intergovernmental organizations will be ineffective.

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 issues linked to energy. In addition, the GEA will identify options for the way forward—both on a global and regional level—and inform policymakers, 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. The GEA will target the needs of a range of stakeholders, providing policy-relevant analysis and capacity-enhancing guidance to national governments and intergovernmental organizations, decision-support material to the commercial sector (energy service companies, investors, and others) and analysis relevant to academic institutions.

The GEA will be a major activity spanning a number of years, and will be produced by bringing together leading international experts from academia, business, governments, and intergovernmental and nongovernmental organizations, selected from throughout the world.

Scientific Achievements in 2008

Highlights

The Global Energy Assessment (GEA) continued into its second year, having been launched at IIASA in January 2007. The GEA is a multi-year and multi-stakeholder activity that aims to help decision makers address the challenges of providing energy services for sustainable development throughout the world. Overall, the GEA effort expanded in scope during 2008 and important milestones were reached. Thirteen convening lead analysts were appointed so that all topical "knowledge modules" (KM) of the Assessment have now been assigned. The second Co-Chair of the Assessment was appointed. Contracts were finalized or monies were received from: the Austrian Development Agency; Petrobras; Italy's Ministry of the Environment and Territory; ClimateWorks Foundation; the U.S. Environmental Protection Agency; the Swedish Research Council for Environment, Agricultural Sciences, and Spatial Planning (Formas); the Swedish Energy Agency; and the World Bank Group's Energy Sector Management Assistance Program (ESMAP) trust fund. The analysis and writing have continued apace, culminating in the completion of the "zero-order draft" or ZOD in December. The ZOD is a first draft of the major analytical report of the GEA intended to give stakeholders an early idea of the key questions being investigated. In addition, it has served as a useful tool to solicit guidance from the GEA Council and feedback from stakeholders in the transition to sustainable energy systems. Also in 2008, GEA participants presented the Assessment in invited talks in a number of international forums, including: the Tällberg Forum (25–29 June); the Beijing High-Level Conference on Climate Change–Technology Development and Technology Transfer (8 November); and the 14th Conference of Parties (COP 14) to the United Nations Framework Convention on Climate Change (UNFCCC) in Poznan (5 December). Amidst all this activity, Jose Goldemberg, Co-President of the GEA Council and the acknowledged originator of Brazil's bioethanol program, was awarded the Blue Planet Prize, the international environmental award sponsored by the Asahi Glass Foundation and given each year to two individuals or organizations making outstanding contributions to solving global environmental problems.

Motivation and Context

During the work of the GEA, a consensus has emerged among the participants that energy and the provision of energy services can be linked directly with many if not all of the key global challenges recognized by the international community. This means that taking action on energy will ameliorate any of a number of global challenges. These challenges will have to be addressed in a world also undergoing rapid change in many other dimensions. Global population is expected to grow from 6.5 to 9 billion people by 2050. All people have ambitions for enhanced wellbeing and see economic growth as important for achieving this. Almost half the world's population lives in poverty, and close to 1 billion people live in abject poverty. Infrastructure investments are huge, urbanization is accelerating, and transportation systems are expanding rapidly. Land use constraints are becoming visible in many places. Given the competing requirements in economic and social development, environmental protection, and security, the challenge faced by decision makers will be to construct a portfolio of policies for dealing with all of the energy-linked challenges simultaneously, adequately, and promptly.

By assessing and synthesizing an extensive range of energy research literature, the GEA is identifying the state of knowl-

edge and key strategic gaps that need to be addressed to support long-term decision making in energy. The GEA will support the broader energy research agenda by contributing to a better understanding of the interlinkages across the range of energy-related challenges, namely, development, security, technology investment, and environmental externalities, by identifying areas where the prevalence of competing objectives may necessitate more sophisticated analytical approaches. Further, the GEA is facilitating exchange among energy experts and leading businesses, governments, and international organizations.

GEA operates with a two-tiered governance structure. The GEA Council is responsible for facilitating high-level engagement with stakeholders. The Council held its second meeting at Lund University, Sweden on 28–29 May 2008. There the Council reviewed and provided comment on an early version of the "zero-order" draft of the major analytical report. The Executive Committee, which is responsible for conducting the analysis and producing the written products, has two Co-chairs, Professor Thomas B. Johansson of Lund University (Sweden), and Feng Fei of the Development Research Centre (DRC) of the State Council of China—the latter newly appointed in 2008. The Executive Committee continued the work of developing the zero-order draft throughout 2008. The Executive Committee met at IIASA in February, May, and September to conduct substantive discussions on the content of the Assessment and to carry out internal peer reviews to ensure the coordination of cross-cutting issues. In addition, it has been holding monthly teleconferences. The zero-order draft was completed in December 2008, after which work proceeded on an internal review.

Although the secretariat is hosted at IIASA, GEA operates through a vast network of participants from across the globe, including substantial contributions from Africa and developing Asia. The analysts convened for GEA provide numerous and diverse viewpoints aimed at challenging the conventional wisdom on energy while synthesizing current knowledge. GEA meetings are held at various locations reflective of the international character of the research. On 4–5 April, the Convening Lead Analyst (CLA) for the KM on rural energy convened a working group meeting in Accra, Ghana. The GEA Council met in Lund, Sweden on 29–30 May. In September, an analysts' meeting on constructing policy portfolios was held at Stanford University in Palo Alto, California, USA. In October, an analysts' meeting on urbanization was held at the New York offices of the United Nations Development Programme, and in December another such meeting on innovation was held in Cambridge, Massachusetts, USA, at Harvard's Kennedy School of Government. In November GEA participants convened a large consultation in China during the Beijing High-Level Conference on Climate Change–Technology Development and Technology Transfer.

Substantive Orientation

The topical outline of the Assessment is split into four knowledge clusters: I) the major global challenges and their linkages to energy; 2) the technologies and resources available for providing energy services; 3) the future energy systems envisioned for addressing the major challenges; and 4) the requisite policies and measures designed to facilitate sustainable energy futures. The outline consists of 25 knowledge modules on specific topics

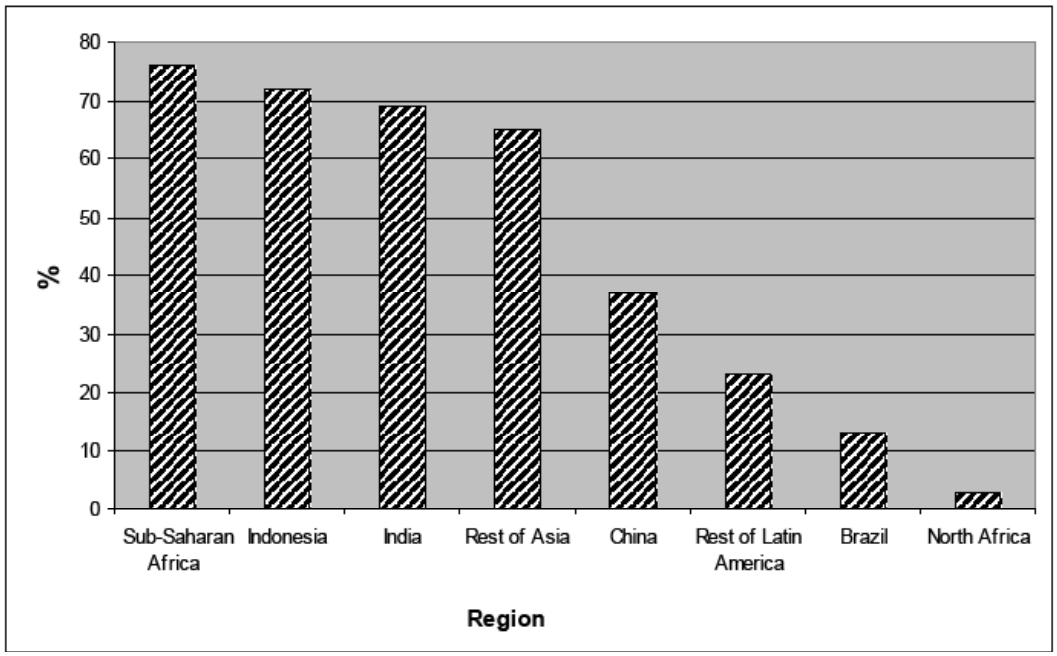


Figure 1. Percentage of population relying on biomass for cooking. An effective strategy to address the energy needs of rural populations is to promote a move from from simple biomass fuels (dung, crop residues, firewood) to the most convenient, efficient form of energy appropriate to the task at hand—usually liquid or gaseous fuels for cooking and heating and electricity for most other uses. Successful programs have been implemented in Asia, China, India, and to a lesser extent in Africa, where a large percentage of households rely on traditional biomass fuels. SOURCE: Stephen Karekezi.

related to these four knowledge clusters and an additional two modules comprising an introduction and an epilog. Each knowledge module is headed by a convening lead analyst, assisted by a workgroup of roughly 10 analysts. A number of meetings were held in 2008 to advance the progress toward completion of the zero-order draft. IIASA hosted a workshop on 3 February during which the GEA Executive Committee members, together with experts in scenario development, discussed the role of scenarios in the GEA. A number of other KM workgroups were held during 2008 including, for example, those on urbanization, policy rationale and portfolios, innovation, and energy end-use efficiency in buildings (residential and commercial).

The GEA has produced some initial findings, which, although preliminary, are illustrative of the linkages between analytical findings and suggested policy responses that are its ultimate goal. As an example, access to modern forms of energy is a key development issue for Africa, where, in the coming decades, the number of people without access to electricity is projected to increase. The use of traditional fuels such as biomass in households for cooking and heat has significant health impacts. It is estimated that roughly 1.6 million premature deaths a year result from exposure to indoor air pollution caused by the burning of solid fuels in poorly ventilated spaces. An effective strategy to address the energy needs of rural populations is to promote a move from simple biomass fuels (dung, crop residues, firewood) to the most convenient, efficient form of energy appropriate to the task at hand—usually liquid or gaseous fuels for cooking and heating and electricity for most other uses. Successful programs have been implemented in Asia, China, India, and to a lesser extent in Africa, where a large percentage of households rely on traditional biomass fuels. Further, the task of gathering firewood and carrying water falls disproportionately on women and children, perhaps numbering in the hundreds of millions. As a result, women and children often miss out on opportunities for education and other productive activities.

In developed countries, there is a different set of challenges. Climate change has become the most consequential linkage between energy and the environment and has associated with it increased risks to coasts, ecosystems, fresh-water resources, and human health. The Intergovernmental Panel on Climate Change (IPCC) has estimated that it will be necessary to reduce net greenhouse gas emissions to zero by mid-century to limit global mean temperature increase to two degrees Celsius above pre-industrial levels by the end of this century—the target level that must be attained to avoid dangerous climate change. Energy production and consumption are the anthropogenic activities responsible for the greatest increase in the atmospheric radiative forcing leading to global warming. Reducing the amount of energy required to deliver various goods, services, or amenities is one way to address the climate changes and other negative

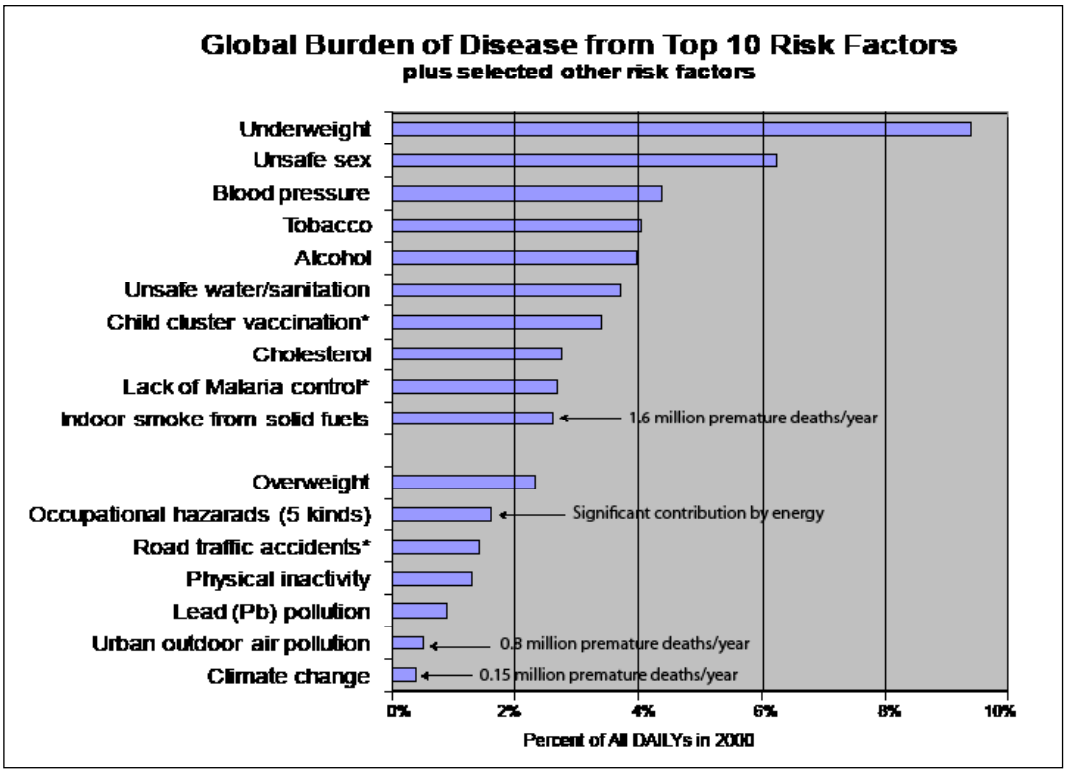


Figure 2. Global burden of disease from top 10 risk factors. The use of traditional fuels such as biomass in households for cooking and heating has significant health impacts. It is estimated that roughly 1.6 million premature deaths a year result from exposure to indoor air pollution caused by the burning of solid fuels in poorly ventilated spaces. Approximately two-thirds of these deaths are the result of acute respiratory infection in children. DALYs: disability-adjusted life years. Source: Smith, K.R., Roggers, J. Cowlin, S.C., 2005. "Household Needs and Ill-Health in Developing Countries: What Improvements Can Be Brought by LP Gas?" Paris, World LP Gas Association.

externalities. Viewed at the national level, accelerating the decline in energy intensity can be an effective means of slowing the acceleration of energy use and the associated warming trend.

Feedback from stakeholders indicates that GEA is not only timely, in that it builds on and leverages the findings from other recent assessments—such as the Millennium Ecosystems Assessment or the IPCC Fourth Assessment Report—but that it also supports other ongoing multilateral initiatives, including the UN Commission on Sustainable Development and UN Energy—the UN's interagency mechanism. The GEA is also relevant to ongoing policy dialogs such as the international negotiations on climate change under the UNFCCC umbrella. For example, the GEA is providing advice vis-à-vis the Bali Roadmap and including participation in COP 14 in December 2008. The Assessment is evaluating future commitments to the reduction of greenhouse gas emissions, for example, to levels 20+ percent below 1990 levels by 2020 and 50+ percent by 2050 and possibly also negative emissions during the second half of the century. Specifically, the GEA will examine resource and technology options and policy interventions needed to achieve such targets.

Resource Mobilization

The GEA Council Co-presidents continued fundraising activities in Europe and in North and South America in 2008. Contracts were finalized or monies were received from: the Austrian Development Agency; Petrobras; Italy's Ministry of the Environment and Territory; ClimateWorks Foundation; the U.S. Environmental Protection Agency; the Swedish Research Council for Environment, Agricultural Sciences, and Spatial Planning (Formas); the Swedish Energy Agency; and the Energy Sector Management Assistance Programme (ESMAP) of the World Bank. Other financial supporters of the GEA include the UN Development Programme, the World Energy Council, the UN Foundation, and UN Development Programme (UNDP). The UN Environment Programme (UNEP), among others, has joined this initiative. In 2009 the GEA will receive US$153,000 in direct support and $789,000 of in-kind support from The H. John Heinz III Center for Science, Economics and the Environment from monies appropriated by the U.S. Congress to support the GEA. A further fundraising development occurred in October, 2008 when the European Parliament acting in plenary adopted a budget amendment authorizing €1,000,000 for a "Contribution to the operational costs of the GEA." The concerted effort regarding fundraising will continue in 2009.

Activities for 2009

Planned milestones for 2009 include completing the "first-order draft" of the Assessment by the end of February for use as an input to the deliberative activities leading up to and including COP 15 in Copenhagen. The first-order draft will be subject to an informal peer review by experts. By year's end, the "second order draft" of the Assessment will be complete and a formal external peer review will commence. The GEA will contribute side events at COP 15 (Copenhagen) as at well as other events in the process leading up to Copenhagen, including during the International Scientific Congress on Climate Change (10–12 March 2009), at which GEA participants will provide the keynote address. GEA will contribute decision-support materials including the "first-order draft" of the major analytical report, which will be made available for multiple stakeholder presentations in March 2009 and onwards.

Also in 2009, the GEA will continue its consultative activities in a number of international forums, including the International Scientific Congress on Climate Change (10–12 March, Copenhagen); World Bank Energy Week (31 March–2 April, Washington D.C.); the 17th session of the UN Commission on Sustainable Development (4–15 May); and COP 15 (7–18 December, Copenhagen). In addition, IIASA is one of three sponsoring organizations of the International Energy Conference: Towards an Integrated Energy Agenda Beyond 2020 (22–24 June, Vienna), at which GEA will Figure prominently.

Members of the GEA Council

Ged Davis (Co-President), International Institute for Applied Systems Analysis
José Goldemberg (Co-President), University of São Paulo, International Institute for Applied Systems Analysis
Dan Arvizu, National Renewable Energy Laboratory (NREL)
Corrado Clini, Italian Ministry for the Environment and Territory
Robert Corell, The H. John Heinz III Center for Science, Economics and the Environment
Bo Diczfalusy, Director-General for Energy, Head of Energy Division, Ministry of Enterprise, Energy and Communications, Swedish Government Offices
Irene Freudenschuss-Reichl, Austrian Ministry for Foreign Affairs
Olav Kjørven, United Nations Development Programme
Celso Fernando Lucchesi, Petrobras
Jamal Saghir, World Bank
John Schellnhuber, Potsdam Institute for Climate Impact Research
Achim Steiner, United Nations Environment Programme
Björn Stigson, World Business Council for Sustainable Development
Detlof von Winterfeldt, International Institute for Applied Systems Analysis
Robert Watson, Department for Environment Food and Rural Affairs and Tyndall Centre at the University of East Anglia
Kandeh Yumkella, United Nations Industrial Development Organization
Zhou Dadi, National Development and Reform Commission, China

Members of the GEA Executive Committee

Feng Fei (Co-Chair), Development Research Centre of the State Council of China; China
Thomas B. Johansson (Co-Chair), University of Lund; Sweden
Nebojsa Nakicenovic (Director), IIASA and Vienna University of Technology; Austria
Luis Gomez-Echeverri (Associate Director), IIASA; Colombia
Rangan Banerjee, Indian Institute of Technology Bombay (IIT); India
Sally Benson, Stanford University; USA
Daniel Bouille, Bariloche Foundation; Argentina

Abeeku Brew-Hammond, The Energy Centre, KNUST; Ghana
Aleh Cherp, Central European University, Budapest; Belarus
Suani T. Coelho, CENBIO-Brazilian Reference Center on Biomass; Brazil
Arnulf Grubler, IIASA and Yale; Austria
Sujata Gupta, ADB; India
Kebin He, Tsinghua University; China
Mark Jaccard, Simon Fraser University; Canada
Suzana Kahn Ribeiro, Federal University of Rio de Janeiro; Brazil
Stephen Karekezi, AFREPREN/FWD; Kenya
Zheng Li, Tsinghua University; China
Lynn Mytelka, UNU-MERIT; Canada
Anand Patwardhan, Indian Institute of Technology Bombay (IIT); India
Keywan Riahi, IIASA; Austria
Hans-Holger Rogner, IAEA; Germany
Joyashree Roy, Jadavpur University; India
Robert Schock, WEC; USA
Kirk Smith, University of California Berkeley; USA
Wim Turkenburg, University of Utrecht; Netherlands
Diana Urge-Vorsatz, Central European University; Hungary
David Victor, Stanford University; USA
Frank von Hippel, Princeton University; USA

GEA Scientific Recognition
See joint ENE/GEA/TNT list.

ENE/GEA/TNT Scientific Recognition

Awards

José Goldemberg

- Co-President of the Council of the Global Energy Assessment has been awarded this year's Blue Planet Prize Award by the Asahi Glass Foundation.

Serving on Advisory Boards and Steering Committees

Arnulf Grubler (TNT)

- Advisory Board Member, UK Energy Research Center, London, UK
- Advisory Board Member, BP–Imperial College Urban Energy Systems Project, London, UK
- Executive Committee Member, Global Energy Assessment, IIASA, Laxenburg, Austria

Volker Krey (ENE)

- Lead Author, Intergovernmental Panel on Climate Change Special Report on Renewable Energy Sources and Climate Change Mitigation (IPCC–SRREN)

Nebojsa Nakicenovic (ENE/GEA/TNT)

- Advisory Board Member, World Development Report 2010: Climate Change, The World Bank, Washington DC, USA
- Member, Advisory Council of the German Government on Global Change (WBGU), Berlin, Germany
- Council Member, Integrated Assessment Modeling Consortium (IAMC), coordinated by the International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria, Energy Modeling Forum (EMF), Stanford University, USA, and National Institute for Environmental Studies (NIES), Japan
- Member, Global Energy International Prize Committee, Russian Research Center "Kurchatov Institute," Moscow, Russia
- Advisory Board Member, Friedrich Schiedel Foundation on "Energy technology," Vienna, Austria
- Chair of the Advisory Board, OMV Future Energy Fund, Vienna, Austria
- Scientific Steering Committee Member, The Global Carbon Project, CSIRO, Canberra, Australia
- Steering Committee Member, International Programme on the Economics of Atmospheric Stabilization (IPEAS), London, UK
- Member, United Nations Sigma Xi Scientific Expert Group on Climate Change and Sustainable Development, Triangle Park, NC, USA
- Member, Organizing Committee of International Energy Economics Conferences (IEWT), Vienna University of Technology, Vienna, Austria
- Member, InterAcademy Council (IAC) Study "Transitions to Sustainable Energy," Amsterdam, the Netherlands
- Member, Working Group on Coupled Modeling, Joint Scientific Committee for the World Climate Research Programme (JSC/WCRP) and CLIVAR Scientific Steering Group, Geneva, Switzerland
- Member, IPCC WGIII Task Group on New Emission Scenarios, Bilthoven, Netherlands
- Scientific Advisory Board Member, Dubrovnik Conference on "Sustainable Development of Energy, Water and Environment Systems," Zagreb, Croatia

Keywan Riahi (ENE/TNT)

- Steering Group Member, Integrated Assessment Modeling Consortium (IAMC)
- Executive Committee Member, Global Energy Assessment, IIASA, Laxenburg, Austria
- Core Writing Team Member, IPCC AR4 Synthesis Report, Geneva, Switzerland

Selected Invited Lectures

Roberto Aguilera (GEA)

- Gave a presentation "Petroleum supply" at a Seminar of the Department of Economic Science, University of Padua, Italy, 28 October 2008.
- Gave a presentation "Natural gas production from tight gas formations: A global perspective" at the 19th World Petroleum Congress in Madrid, Spain, 29 June– 3 July 2008.
- Gave a presentation "Depletion and the future availability of petroleum resources" at the 31st IAEE International Conference, Istanbul, Turkey, 18–20 June 2008.
- Gave a presentation "Global possibilities of future methane and hydrogen economies" at the SPE Gas Technology Symposium in Calgary, Alberta, Canada, 16–19 June 2008.

Ged Davis (GEA)

- Participated in the World Energy Council Executive Assembly, and the World Energy Congress, Mexico City, Mexico, 7 November 2008.

- Participated in the debate in the "Comment: Visions Series" entitled "When do We Reach the Tipping Point for Lifestyle Changes?" with the EU External Relations Commissioner, Benita Ferrero-Waldner, Brussels, Belgium, 30 June 2008.
- Participated as a Contributor to the Session "In Search of the Common Sense" at the "Tällberg Forum 2008: How on earth can we live together?" Tällberg, Sweden, 25–29 June 2008.
- Participated in the Round Table on "Sustainable Development: Mobilising Investments in Low–Carbon Energy Technologies," OECD Headquarters, Paris, France, 27–28 April 2008.
- Gave a presentation at the H. John Heinz III Center for Science, Economics and the Environment, 14 March, 2008.
- Participated in the National Academies Summit on "America"s Energy Future," Washington DC, 13–14 March, 2008.
- Participated in the "Environment/Climate Change/Energy/Global Governance Meeting" cosponsored by Japan Institute of International Affairs and Center for Global Studies, University of Victoria in Tokyo Japan, 12–13 February 2008.

Christopher Doll (TNT)

- Gave a presentation "Money is time: An alternative perspective on poverty" in the Session on "Poverty and Economic Development" at the 2008 Association of American Geographers Meeting, Boston, MA, USA, 15–19 April 2008.

Jose Goldemberg (GEA)

- Gave a presentation at the H. John Heinz III Center for Science, Economics and the Environment, 14 March, 2008.
- Participated in the National Academies Summit on "America's Energy Future," Washington DC, 13–14 March, 2008.

Arnulf Grubler (TNT)

- Gave a presentation "Technology dynamics, heterogeneity, and complexity in a climate constrained world" at the Geography and Regional Development Colloquium, University of Arizona, Tuscon, AZ, 21 November 2008.
- Gave a presentation "Forgetting by doing? The economics of the French nuclear expansion program" at the International Workshop on "The Economics of Technologies to Combat Global Warming," Snowmass, CO, 4–5 August 2008.
- Gave a presentation "Climate change and the transformation of global energy systems" at the Vienna University Summer Academy "Transformations – Challenges of Globalization," Strobl, Austria, 31 July 2008.
- Gave a presentation "Climate change: The scientific basis" at the Conference on "Global Climate Change: Building Consilience between Science, Security, and Policy" at the S. Rajaratnam School of International Studies, Nanyang Technological University, Singapore, 14 July 2008.
- Gave a presentation "Assessing global and regional energy needs and challenges" at the African Union, BMZ, and UNIDO International Conference on "Renewable Energies in Africa," Dakar, Senegal, 17 April 2008.
- Gave a presentation "Development of energy systems: Drivers and rates of change in past and future" at the Volkswagen AG, Wolfsburg, Germany, 13 February 2008.
- Participated as Advisory Board Member in the "Advisory Board Meeting of the UK Energy Research Centre (UKERC)," UKERC, London, UK, 18 January 2008.
- Gave a presentation "Climate change implications for future energy systems" at the Austrian Electricity Board (*Verbundgesellschaft*), Vienna, Austria, 17 January 2008.

Thomas B. Johansson (GEA)

- Gave a presentation "Global Energy Assessment (GEA)" at the "Special Event on GEA" organized during the United Nations Climate Change Conference (COP14/MOP 4), Poznan, Poland, 10 December 2008.
- Gave a presentation "Global Energy Assessment (GEA)" at the Special Event during the Beijing High-Level Conference on "Climate Change: Technology Development and Technology Transfer" co–organized by the Chinese Government and the United Nations, Beijing, China, P.R., 8 November 2008.
- Participated in the "Washington International Renewable Energy Conference" (WIREC 2008), Washington DC, 4–6 March 2008.
- Gave a presentation "The challenges for the systems of global renewable resources: The energy case in a systems perspective," House of Sweden, Washington DC, 3 March 2008.

Volker Krey (ENE)

- Gave a presentation "Climate change, energy prices, and technological change: How to deal with future uncertainties in energy systems models" at a Research Seminar, Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany, 27 November 2008.
- Gave a presentation "Risk hedging strategies under energy system and climate policy uncertainties" at the "EMF Uncertainty Workshop," Middletown, CT, 29–31 October 2008.
- Gave a presentation "IIASA MESSAGE: Short-term mitigation potentials, long-term development and uncertainties" at the 2nd International Workshop on "Sector-based GHG Emission Reduction Potential," Paris, France, 21–22 October 2008.
- Gave a presentation "Needs and opportunities in the study of energy and climate" at 1st Workshop on "Deep Carbon Cycle" sponsored by the Carnegie Institution and the Alfred Sloan Foundation, Washington DC, USA, 15–17 May 2008.

- Gave a presentation "IIASA MESSAGE: Baseline vs. stabilization scenario GHG mitigation & sectoral technology representation" at the International Workshop on "Sector-based GHG Emission Reduction Potential," Paris, France, 7–8 May 2008.
- Gave a presentation "Climate change, energy prices and technological change–dealing with future uncertainties" at the 10th Symposium of Energy Innovation organized by the Institute for Electricity and Energy Innovation (IEE), Graz University of Technology, in collaboration with the Austrian Association for Electrotechnics and Austrian National World Energy Council Committee, Graz, Austria, 13–15 February 2008.
- Gave a presentation "Implications of technology- and policy-related uncertainties in an integrated energy systems modeling risk management framework" at the EMF Workshop, Washington DC, USA, 5–8 February 2008.

Tieju Ma (TNT)

- Gave a presentation "Modeling uncertainties of technological learning with stochastic optimization" at the 9th International Symposium on "Knowledge and Systems Sciences," jointly with the 4th Asia-Pacific International Conference on Knowledge Management, Guangzhou, China, 11–12 December 2008.
- Gave a presentation "Coping with uncertainties in endogenous technological change model" at the 2008 IEEE International Conference on "Systems, Man, and Cybernetics (SMC 2008)," Singapore, 12–15 October 2008.
- Gave a presentation "A risk-constrained optimization model of endogenous technological change" at the Workshop on "Modeling and decision support for network-based services," IFIP Working Group 7.6, Warsaw, Poland, 1–3 September 2008.

Nebojsa Nakicenovic (ENE/GEA/TNT)

- Gave a presentation "Introduction to the Global Energy Assessment (GEA)" at the "Special Event on GEA" organized during the United Nations Climate Change Conference (COP14/MOP 4), Poznan, Poland, 10 December 2008.
- Gave a presentation "Energy efficiency and low-carbon technologies" at the UN–Energy Side Event on "Energy Efficiency in the Post-2012 Framework: Key Issues and Challenges" at the United Nations Climate Change Conference (COP14/MOP 4), Poznan, Poland, 10 December 2008.
- Gave as Advisory Board Member a presentation "Oxy-fuel carbon capture and storage technologies" and chaired the "OMV Future Energy Fund Board Meeting," Vienna, Austria, 1–2 December 2008.
- Gave a keynote presentation "Low-carbon technologies and climate change" at the "Energy Delta Convention 2008," organized by the University of Groningen, Groningen, Netherlands, 19 November 2008.
- Gave a keynote presentation "Low-carbon technologies and risk management" at the European Parliament Conference on "A Global Contract Based on Climate Justice: The Need for a New Approach Concerning International Relations," European Parliament, Brussels, Belgium, 11 November 2008.
- Gave a presentation "Global Energy Assessment (GEA)" at the Special Event during the Beijing High-Level Conference on "Climate Change: Technology Development and Technology Transfer" co-organized by the Chinese Government and The United Nations, Beijing, China, P.R., 8 November 2008.
- Gave a presentation "New evidence on BAU emission scenarios: how quickly are emissions growing?" at the High-Level Roundtable on "Regional Economics of Climate Change Study," convened by Sir Nicholas Stern, Hong Kong, China, P.R., 28–29 October 2008.
- Gave a presentation "Global Energy Assessment (GEA)" at the "Global Energy Assessment Launch Event in China" and participated in the International Workshop on "Low-Carbon Energy Technology and Policy," organized by the Institute of Energy and Environmental Economics, and the Institute of Engineering Thermophysics, Chinese Academy of Sciences, Beijing, China, P.R., 21 October 2008.
- Gave a presentation "Enhancing analytical capabilities to inform policy" at the Conference on "Assessing Economic Impacts of Greenhouse Gas Mitigation" organized by the US National Academies, Washington DC, USA, 2–3 October 2008.
- Gave a presentation "Modeling zero-carbon growth: Assessing technological options and governance requirements at the national level" at the International Policy Workshop on "Climate Governance and Development" organized by the World Bank in cooperation with InWEnt Capacity Building International, Berlin, Germany, 28–30 September 2008.
- Gave an opening presentation "The role of IAMC and scenario process" at the "Workshop of the Integrated Assessment Modeling Consortium (IAMC)," Baden, Austria, 23–24 September 2008.
- Gave a keynote presentation "What are the challenges?" at the Kick-off Conference "Future Climate: Engineering Solutions" organized by the Danish Society of Engineers, Copenhagen, Denmark, 18 September 2008.
- Gave a panel presentation "Energy versus climate change" at the "Global Economic Symposium" organized by the Kiel Institute for the World Economy and the Ministry of Science, Economics and Transport of Schleswig-Holstein, Plön, Germany, 4–5 September 2008.
- Participated in the "29th Session of the Intergovernmental Panel on Climate Change," Geneva, Switzerland, 31 August 2008.
- Gave a presentation "Mobility and climate change" in "Workgroup 8: Traffic and Transport" at the "Alpbach Technology Forum 2008," Alpbach, Austria, 21–22 August 2008.
- Gave a presentation "Modeling dynamics and uncertainty of technological change" at the Workshop on "Modeling Technological Innovation" organized by the Santa Fe Institute, Santa Fe, USA, 12–16 August 2008.

- Gave as co-organizer a presentation on "Modeling technological change, R&D and investment requirement" at the Workshop on "The Economics of Technologies to Combat Global Warming," sponsored by the Kauffman Foundation and the Energy Modelling Forum, Snowmass, CO, USA, 4–5 August 2008.
- Gave a presentation "Methane hydrates" and led the discussion in the Session "Scenarios: Ideas for Integrating" at the "1st Bioenergy Workshop of the Earth System Science Partnership" organized by Global Carbon Project (GCP), at the 8th meeting of the GCP Scientific Steering Committee, Piracicaba, Brazil, 21–27 July 2008.
- Gave a presentation "Mitigation strategies for stabilizing greenhouse gas concentrations" at the International Meeting on "Mid–Long Term Strategy for Climate Change" organized by the Global Industrial and Social Progress Research Institute (GISPRI), Tokyo, Japan, 29 June–1 July 2008.
- Gave a presentation "Mitigation costs and strategies" at the Professional Meeting on "Global Warming Issues" organized on the occasion of the G8 Meeting by the Japan Science Council (JSC), Sapporo, Japan, 23–26 June 2008.
- Gave a presentation "Transitions toward a decarbonized energy future" in the Plenary Session "Energy" at the 11th Annual Conference on "Future of Global Economy" organized by the Global Trade Analysis Project (GTAP), Helsinki, Finland, 12–13 June 2008.
- Gave as Member of the IIASA Delegation a presentation "Energy perspectives and climate change" at the Conference "IIASA Energy Day in Poland" organized by the Systems Research Institute of the Polish Academy of Sciences, Warsaw, Poland, 10 June 2008.
- Gave a presentation "Market conditions for renewable energy versus fossil fuels" at the "Global Renewable Energy Forum" organized by UNIDO and the Federal Government of Brazil, Foz do Iguacu, Brazil, 18–22 May 2008.
- Participated as Discussion Leader of the Session "Energy and Climate" in the 1st Workshop on "Deep Carbon Cycle" sponsored by the Carnegie Institution and the Alfred Sloan Foundation, Washington DC, USA, 15–16 May 2008.
- Gave as Member of the IIASA Delegation two presentations "Global energy perspectives, technology and climate" and "Future energy development and emissions mitigation" at the "IIASA/KOSEF Meeting," Seoul, South Korea, 28–30 April 2008.
- Gave a presentation "Energy generation, land-use change and their consequence for the atmosphere" at the International Meeting "Breathe and Die! Air Pollution Matters" organized by the United Nations University at the UN Headquarters, New York, USA, 23 April 2008.
- Participated as Contributor to the Report "World Energy Outlook 2008: The road to Copenhagen" in its Workshop co-hosted by the International Energy Agency (IEA) and the Ministry of Foreign Affairs of Denmark, Copenhagen, Denmark, 17 April 2008.
- Gave a presentation "Mitigation costs and benefits from a global perspective" in the Session "Consequences of Geo-Engineering and Mitigation as Strategies for Responding to Anthropogenic Greenhouse Gas Emissions" at the "General Assembly of the European Geosciences Union," Vienna, Austria, 13–18 April 2008.
- Participated as Leading Discussant in the International Workshop "Energy, Climate and Global Security" organized by the Lawrence Livermore National Laboratory (LLNL), Livermore, CA, USA, 31 March–4 April 2008.
- Participated in the Expert Roundtable on "Research Priorities in Sustainable Development" organized by the Earth Institute of Columbia University and sponsored by the National Science Foundation (NSF), Washington DC, USA, 5–6 March 2008.
- Gave a presentation *"Globale Energieszenarien, die Klimaproblematik und der potential alternativer Energieträger"* at the "Annual Meeting of the Austrian Agency for Alternative Propulsion Systems," organized by TechGate, Vienna, Austria, 4 March 2008.
- Gave as Expert of the World Energy Council Austrian National Committee a presentation "Long-term mobility and energy perspectives" in the Session "Fuels and Mobility" at the 1st International Conference "Mobility & Energy – COME 2008" organized by the World Energy Council, Vienna University of Technology, Siemens, and Austrian Ministry for Transport, Innovation ,and Technology, Vienna, Austria, 28–29 February 2008.
- Gave a presentation "Global Energy Assessment (GEA) and future energy trends" in the Session "Issues and Projected Trends in Energy and Sustainable Development" at the "UN Energy General Meeting" hosted by UNIDO, Vienna, Austria, 25–26 February 2008.
- Gave a presentation "Costs and benefits of emissions mitigation and the value of technology for stabilizing climate change" at the RITE International Symposium on "Global Warming and Sustainable Development," Tokyo, Japan, 16–18 February 2008.
- Gave a presentation "Energy perspectives and climate change" at the 10th Symposium of Energy Innovation organized by the Institute for Electricity and Energy Innovation (IEE), Graz University of Technology, in collaboration with the Austrian Association for Electrotechnics, and Austrian National World Energy Council Committee, Graz, Austria, 13–15 February 2008.
- Participated as member in the Roundtable of the 1st Task Force on "Sustainable Energy" organized by the National Science Foundation (NSF), Washington DC, USA, 8 February 2008.
- Gave an opening presentation "Integrated Assessment Modeling Consortium (IAMC)" at the Workshop on "Integrated Assessment Modeling Consortium" co-organized by Energy Modeling Forum, Integrated Assessment Modeling Consortium and Analysis, Integration, and Modeling of the Earth System, Washington DC, USA, 6–7 February 2008.

- Gave a presentation "Global Energy Assessment (GEA)" both at the Federal Ministry for Environment, Nature Conservation and Nuclear Safety, and at the Potsdam Institute for Climate Impact Research, Berlin and Potsdam, Germany, 23 January 2008.
- Gave a presentation "Global Energy Assessment (GEA)" at the Department of Environment Food and Rural Affairs and at the World Energy Council, London, UK, 7–10 January 2008.

Keywan Riahi (ENE/TNT)

- Gave a presentation "Global energy transitions and the challenge of climate change" at the "17th Forum, Energy Day in Croatia," Zagreb, 21 November 2008.
- Gave a presentation "IIASA GGI scenarios" at the General Assembly of the 6th Framework Programme's Project on "Water and Global Change," Bratislava, Slovakia, 6 November 2008.
- Gave a presentation "Stochastic uncertainty modeling" at the "EMF22: Uncertainty Subgroup Meeting," Middletown, CT, 29–31 October 2008.
- Gave a presentation "Development of new IPCC scenarios" at the Workshop "FP7 & Work on Climate Scenarios for IPCC AR5," European Commission, Brussels, 29–30 September 2008.
- Gave a presentation "Decision making and uncertainty" at the EMF Summer Workshop on "Climate Change Impacts and Integrated Assessments," Snowmass, CO, USA, 28 July – 3 August 2008.
- Participated as Steering Group Member in the EMF24 Meeting on "Climate Policy Scenarios for Stabilization and in Transition" and co-chaired a session at the IAMC–AIMES Workshop on "Planning and Integration," Washington DC, USA, 5–8 February 2008.

Editorships of (9) Journals

Arnulf Grubler (TNT)

- *Journal of Industrial Ecology*, Editorial Board Member
  Technological Forecasting and Social Change, Advisory Board Member

Tieju Ma (TNT)

- *International Journal of Knowledge and Systems Sciences*, Editorial Board Member
- *International Journal of Data Mining, Modeling and Management*, Editorial Board Member

Nebojsa Nakicenovic (ENE/GEA/TNT)

- *Climate Policy*, Editorial Advisory Board member
- *Géotechnique*, Editor
- *International Journal of Energy Sector Management*, Editorial Board Member
- *Technological Forecasting and Social Change,* Associate Editor: Europe

Keywan Riahi (ENE/TNT)

- *Energy Economics*, Associate Editor

Part IV

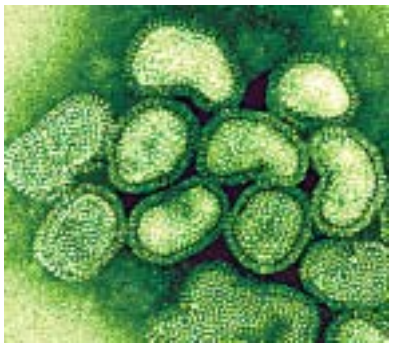
Special Projects

Health and Global Change Project

Landis MacKellar
mckellar@iiasa.ac.at

Objectives

The Health and Global Change (HGC) Project's long-term goal is to contribute to research and deepen international policy dialog related to health—considered one of the human dimensions of global change. IIASA's Science Advisory Committee counseled that HGC begin by concentrating on economic and social aspects of infectious disease and responses thereto. HGC continues to work in the area of infectious disease, and in its 2008–2010 extension, is playing a key role in the International Science Council (ICSU) Planning Group on "Health and wellbeing in a changing urban environment."



Health is a growing global concern, as is dramatically evidenced by the threats of Severe Acute Respiratory Syndrome (SARS), bio-terrorism, and pandemic influenza.

Scientific Achievements

Workshops

HGC hosted the first and second meetings of the ICSU Planning Group on urban health in January and June 2008, in the context of which six IIASA research programs gave presentations. As Chair of the Planning Group, HGC project leader Landis MacKellar chaired the third meeting of the Planning Group at ICSU headquarters in Paris on 16–17 December 2008.

In November 2008 HGC researchers Landis MacKellar and Andrew Noymer participated in the symposium "Urbanization and Environment in China," in Beijing, jointly organized by IIASA and Peking University's Institute of Population Studies. This workshop continued the collaboration which has been established between the two institutions, resulting in the joint workshop "Pandemic influenza in China—Challenges, Responses, Needs" in October 2007.

Colloquia/Seminars/Lectures/Presentations, 2008

Andrew Noymer

- "The twentieth century evolution of American mortality." Department of Sociology, New York University, 8 December 2008.
- "Early life influences: How do survivors fare after mortality crises?" Department of Nutrition, Food Studies, and Public Health, New York University, 9 December 2008.
- "War, race, and disease: Tuberculosis in black and white troops in the Civil War." Population, Society, Inequality Seminar, University of California, Irvine, 25 November 2008.
- Flumodcont Project Technical Meeting, "Survey methods for population behavior during seasonal and pandemic influenza," Istituto Superiore di Sanità, Rome, 2008. High-stakes collective action, panic behavior, and planning: Insights from sociology for pandemic preparedness (by invitation).
- Keystone Symposium, "Pathogenesis and Control of Emerging Infections and Drug Resistant Organisms," Bangkok, 2008. Using routine mortality data to look for pre-pandemic signatures. Abstract 242, poster session 2.
- Fourth Joint Japan–North America Mathematical Sociology Conference, Redondo Beach, 2008. A simulation study of interracial dating dynamics. Andrew Noymer, Cynthia Feliciano, and Belinda Robnett. Session 4.
- Population Association of America, 2008. Annual Meeting, New Orleans. Selective mortality in Norway during the 1918 flu pandemic. Session 125.
- Population Association of America, 2008 Annual Meeting, New Orleans. Early-life Influences and the Seasonality of Mortality: Re-Examining the Doblhammer Effect. Andrew Noymer and Bert Kestenbaum. Session 158.

Steven Ney

- "Going Global? The scope, structure and impact of policy conflict about global health issues," SOSS Capstone Seminar Series.
- "Going Global? The scope, structure and impact of policy conflict about global health issues," BSA MedSoc Annual Conference, University of Sussex, 4–6 September, 2008.
- "Globalisation and Health Systems: A Systems Approach to Comparing Institutions of Health Care Provision," APPAM Singapore Conference 2009, 7–9 January 2009.

Book Reviews

Andrew Noymer

- The health of populations: General theories and particular realities, by Stephen J. Kunitz. *Population and Development Review* 35(1): forthcoming (2009)
- Low income, social growth, and good health: A history of twelve countries, by James C. Riley. *Journal of Interdisciplinary History* 39(3):400–402 (2008)

Editorships / professional service

Landis MacKellar

- Editor in Chief, *Population and Environment* (Springer), 2004–2007.
- Chair Program Committee, IIASA Conference 2010.
- Chair, IIASA Internal Research Committee, January–June 2009.
- Chair, ICSU Planning Group "Health and wellbeing in our changing urban environment," June 2008–2010.

Andrew Noymer

- Board member, Society of Biodemography and Social Biology (SBSB), 2005–2007
- Editorial board member, *Contemporary Sociology*, 2007–2008.
- Refereed for: *American Journal of Epidemiology*; *Canadian Studies in Population*; *Infection, Genetics and Evolution*; *Social Biology*; *Social Psychology Quarterly*; *Social Science History*; *Social Science & Medicine*.

Policy advisory work, 2008

In 2008, HGC staff member **Clara Cohen**, financed by the U.S. National Academy of Sciences African Science Academy Development Initiative (ASADI):

- Authored and published US Institute of Medicine workshop summary, "Design Considerations for Evaluating the Impact of PEPFAR (President's Emergency Plan for AIDS Relief)." Full citation: Institute of Medicine (IOM) 2008. Design Considerations for Evaluating the Impact of PEPFAR: Workshop Summary. Clara Cohen, Michele Orza, and Deepali Patel, Rapporteurs. The National Academies Press: Washington, DC.
- Mentored Nigerian Academy of Science in publishing and disseminating "Blood Safety in Nigeria: Summary of a Workshop," and in planning, implementing, and summarizing workshops on under-five mortality, health systems, and primary health care.
- Mentored Nigerian Academy of Science in preparing a work plan and selecting a topic for its first consensus study
- Mentored Cameroon Academy of Sciences in disseminating "Prioritizing Food Security Policies for Health and Development in Africa."
- Authored 5-year report of the African Science Academy Development Initiative, US National Academy of Sciences
- Authored article on African Science Academy Development Initiative for the American Society of Cell Biology newsletter, April 2008 ASCB Newsletter, Volume 31, #4; pages 21–23.

In 2008, **Landis MacKellar**

- Provided short-term technical assistance on pension reform in Armenia under the USAID Project "Social Protection Systems Strengthening" project.
- Contributed to the Asian Development Bank technical assistance project "Implementing pensions for the unorganized sector in India."
- Was international team leader for European Commission Joint Evaluation Unit evaluations of development cooperation with Lao PDR, Viet Nam, and the Association of Southeast Asian Nations (ASEAN).
- Was international team leader for UNDP evaluations of capacity building in Serbia and the "Severance to Job" project in Serbia.
- Provided expertise to the European Fundamental Rights Agency on child victims of human trafficking and unaccompanied immigrant minors in irregular situations.
- In 2008 Steven Ney Was senior expert on environment and higher education/research for the European Commission Joint Evaluation Unit evaluating development cooperation with Thailand, Malaysia, and the Association of Southeast Asian Nations (ASEAN).

Integrated Modeling Environment Project

Marek Makowski
marek@iiasa.ac.at

Strategic Goal and Objectives

In its third year the Integrated Modeling Environment (IME) Project achieved further significant progress in meeting its strategic goal, namely, *to build capacity to meet IIASA's growing needs for integrated modeling support where commonly known methodology and/or general-purpose modeling tools are inadequate*. The long-term aim is to strengthen IIASA's in-house capabilities and competitive advantage in modeling complex problems.

The IME strategic goal is achievable only because the small in-house team is greatly supported by colleagues from: (1) collaborating IIASA programs, and (2) a network of collaborating research institutes and universities.

The IME strategic goal is being reached through achieving the following operational objectives:

1. Integrate and extend modeling methods and tools developed to address individual demands into an advanced Web-based modeling environment adapted specifically to the needs of IIASA programs.
2. Develop methods and tools for policy analyses to cope with inherent endogenous uncertainties and risks with potential catastrophic consequences, proper representation of abrupt changes, spatial and temporal distributional heterogeneities, vulnerabilities, and robust solutions.

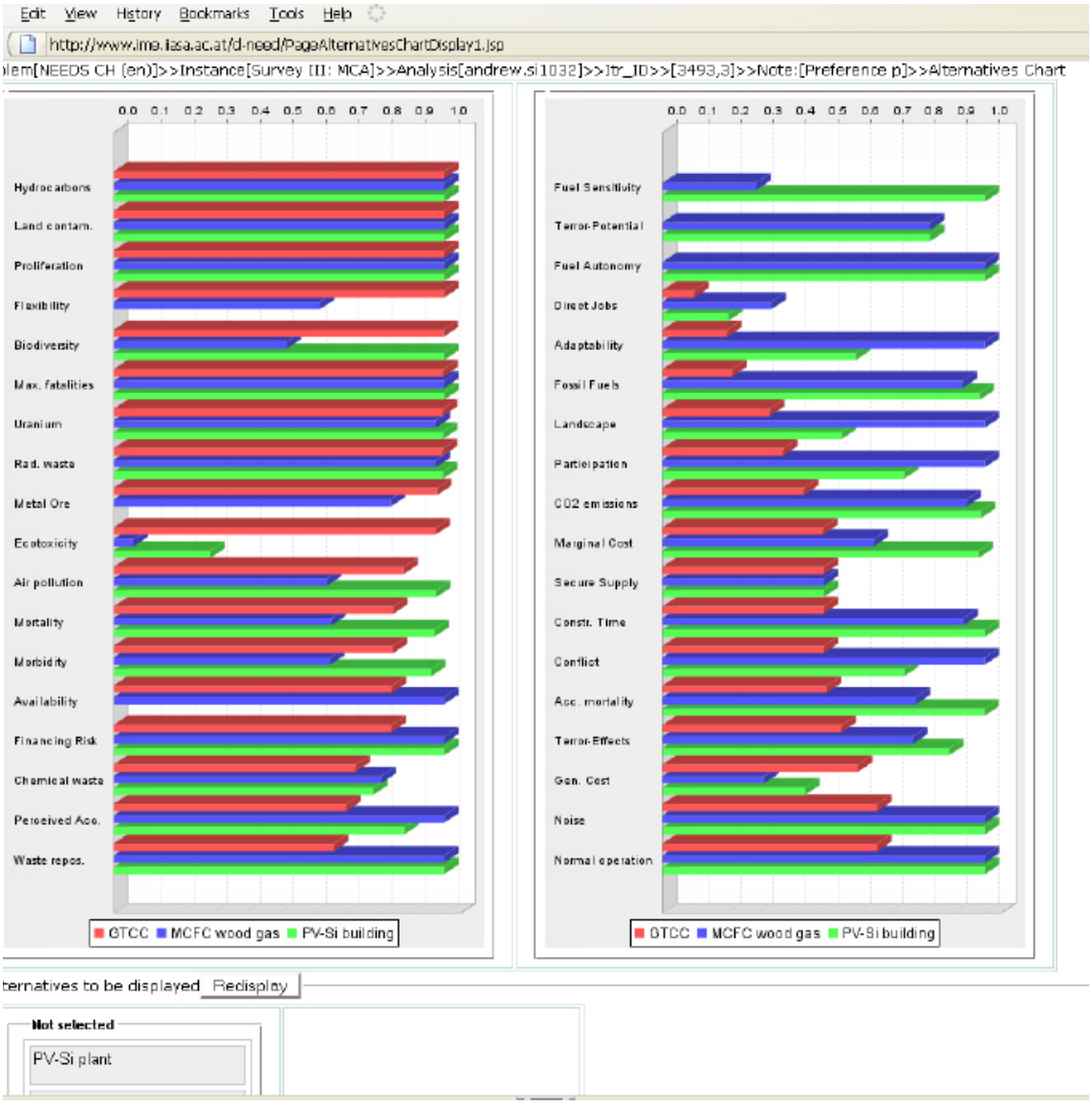


Figure 1. Attributes of future energy technologies and specification of user preferences for their multicriteria analysis

3. Develop methodology and tools for integrated model analysis aimed at combining the capabilities of different methods (such as various types of simulation, optimization, multicriteria model analysis, sensitivity analysis) with data analysis (including data mining, estimation, down- and upscaling) technology.

Scientific Achievements in 2008

The IME objectives are mutually dependent; therefore in IME's research, it is difficult to associate any one research activity with a specific objective. However, the activities for 2008 described below are organized according to their main contribution to one of the three IME objectives. Scientific achievements are described in sixteen 2008 publications; several more documenting the 2008 research will be published in 2009. The following summary of the research reflect the main results of IME publications.

Advanced Web-based Modeling Environment

In 2008 we implemented a dedicated Web site for multicriteria analysis of future energy technologies. This work was based on earlier IME research on approaches to Web-based interactive multicriteria analysis of complex problems of discrete alternatives. (Here, "complexity" refers to the number of criteria and their value distributions, and the number of alternatives). The site was available to over 3,000 stakeholders from European countries who were invited to carry out multicriteria analysis of the technologies developed within the Integrated Project NEEDS, funded by the European Union (EU). Some 160 stakeholders completed the analysis. The results of this analysis provided a basis for the second stage analysis carried out by the energy specialists who developed recommendations for future energy technologies, taking into account their economic, environmental, and social characteristics, and the stakeholder preferences. Thus

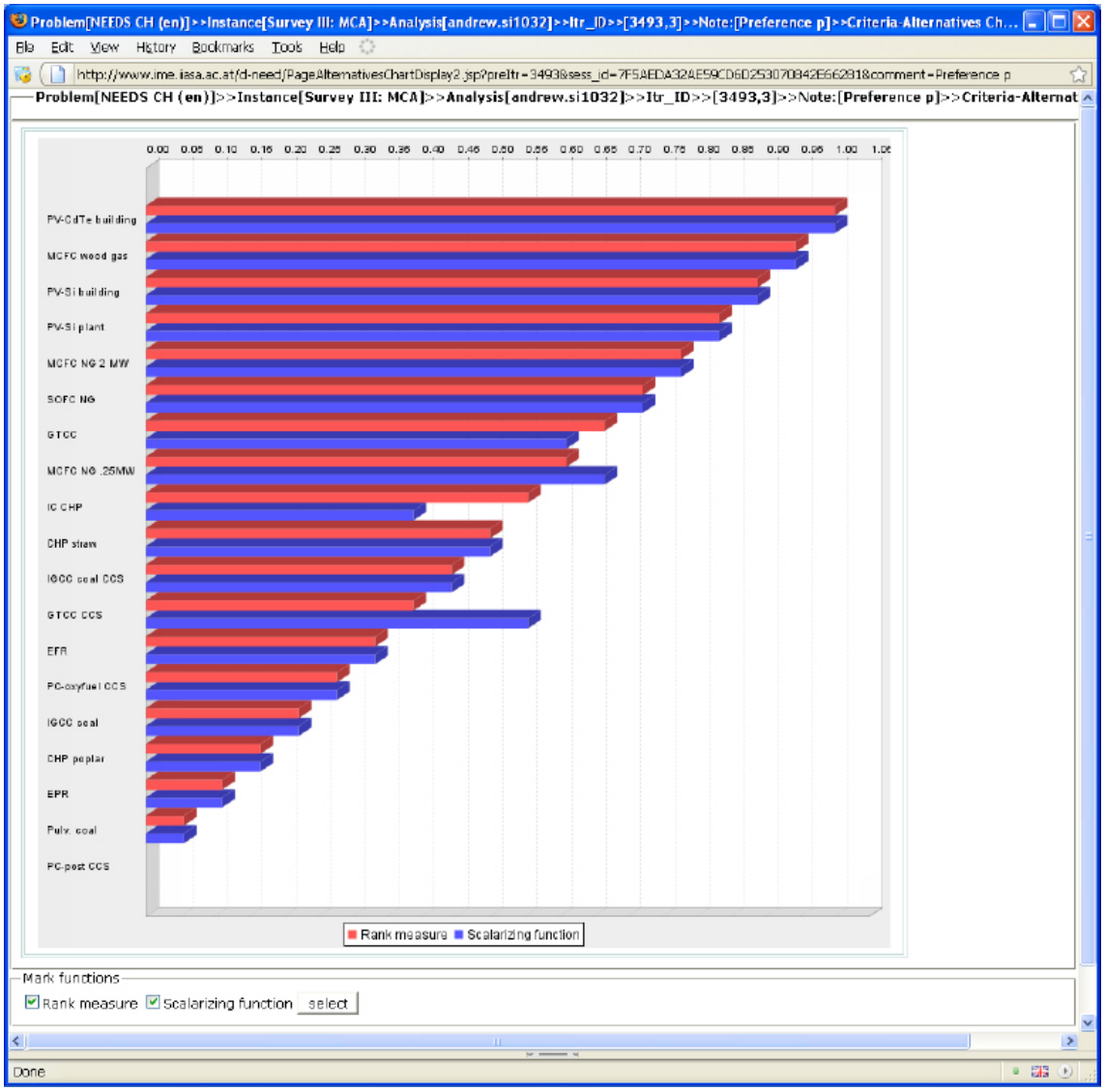


Figure 2. Characteristics of future energy technologies in terms of the corresponding criteria values

this work is a good example of developing novel methodology and tools supporting public participation in policymaking.

The Structured Modeling Technology (SMT) prototype developed by the IME provides a Web-based modeling environment supporting interdisciplinary teams throughout the modeling process (model specification, data processing, generation of model instances, and integrated model analysis). In 2008 we started implementation of the second version of the SMT, which is based on the SMT prototype developed and used at IIASA and collaborating institutions in 2005–2007. The new version is built not only on the experience using the first one, but also on the research done in 2006–2007. This earlier research addressed the methodological problems needing to be solved so that adequate support could be provided for handling the new generation of IIASA models that are not only growing fast, both in complexity and size, but also pose new requirements for the whole modeling process, including: 1) efficient management of complex indexing structures needed for handling data structures with a huge number (over 109) of possible combinations of indices values; and 2) analysis of the semantic consistency of complex algebraic expressions.

Coping with Endogenous Uncertainty and Risks

Proper integrated modeling and decision analysis of ongoing socioeconomic and environmental global changes raise new fundamental methodological challenges. IME thus continues to research the key methodological issues of inherent uncertainties and risks, interdependencies, trade-offs between ex ante (anticipative) and *ex post* (adaptive) decisions, spatio-temporal (economic, social, environmental, risk exposures, political, etc.) heterogeneities that are critical elements of these processes and that have to be properly modeled for designing robust policy decisions. Methods for decision making under uncertainties and related issues of risk management, in particular, adaptive Monte Carlo optimization approaches, have been at the center of methodological developments in the last couple of decades. However, these methods mainly consider relatively simple systems facing external sources of risks and uncertainty, which, in particular, allows the data and uncertainty analysis to be separated from decision analysis. Such a separation is typically impracticable when it comes to dealing with catastrophic risk management,

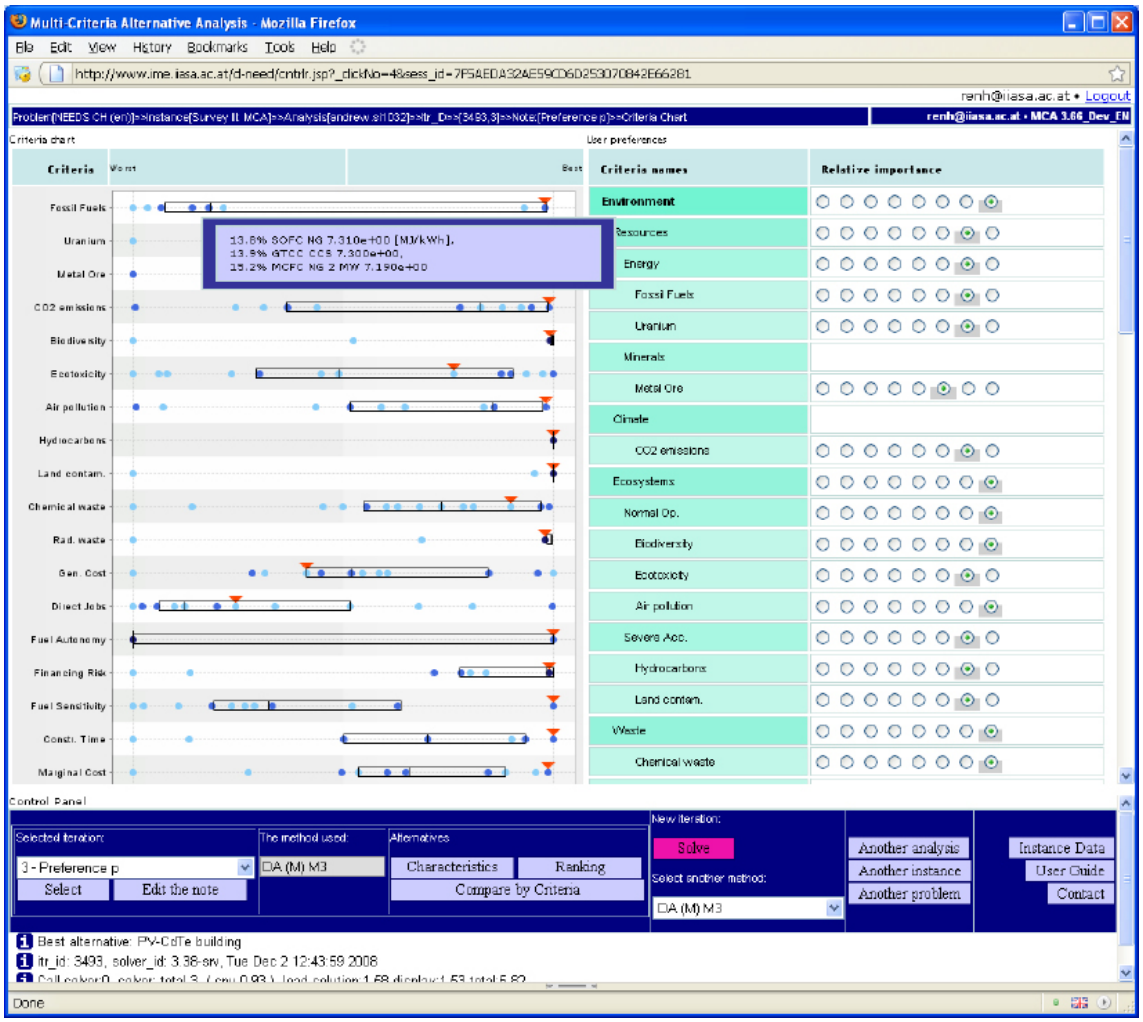


Figure 3. An example of ranking of future energy technologies corresponding to the trade-off between criteria that resulted from a specified relative importance of criteria.

where diversified knowledge relevant to the problem has to be combined with scarce data in order to design a robust strategy which is also sensitive to events that have never occurred.

In 2008 the research on coping with uncertainty that focused on integrated modeling of robust decisions was carried out mainly in collaboration with the Land Use Change (LUC) and Forestry (FOR) programs of IIASA, and with several colleagues from collaborating institutions. The main results include:

- Planning sustainable agricultural development, spatio-temporal management of endogenous land-use related catastrophic risk;
- Management of a multipurpose reservoir for agricultural and energy production, a fishery, water storage, and flood protection;
- Investments under uncertainty and increasing returns;
- Discounting for robust long-term investments under heterogeneous spatio-temporal exposures to extreme events;
- Robust CO_2 emission trading schemes under uncertain costs and emissions;
- Evaluation of preparedness and response strategies for catastrophic events;
- Modeling of networks under risk and uncertainties with applications in energy, finance, telecommunications, and analysis of resilient social networks; and
- Pricing of catastrophe bonds and options focused on applications to integrated management of risks related to natural disasters.

Moreover, during 2008 a book, *Coping with Uncertainties: Robust Decisions*, was prepared in collaboration with several IIASA programs and colleagues from our research network. The book will be published by Springer-Verlag in 2009. Topics covered in the book include the proper modeling of spatio-temporal or socioeconomic and environmental heterogeneities, in particular, the occurrence of potential extreme events, abrupt changes, discontinuities, and the endogenous exposures to them of different agents and values, as well as global/local scaling and decision-oriented harmonization of multi-scale data (upscaling and downscaling methods).

Integrated Model Analysis

Building on long-term past research in the Multicriteria Model Analysis (MCMA) field, the IME continued in 2008 to lead the multicriteria analysis activities within the EU-funded Integrated Project NEEDS. Multicriteria analysis of new energy technologies is characterized by four main challenges:

- It is done for a large set of alternatives, each characterized by a large number of criteria organized into a hierarchical structure;
- The criteria values have multimodal distributions;
- The interactive analysis process involved over 3,000 European stakeholders with diverse backgrounds and conflicting interests; and
- The results of interactive analyses by stakeholders provided a basis for the second-stage analysis aimed at developing policy advice on future energy technologies.

With no methods available to effectively support analysis of such problems, IME in 2008 developed over 20 new methods for this class of problems, and implemented them as part of a Web site for interactive multicriteria analysis. These methods were tested in collaboration with partners from the Paul Scherer Institute (Switzerland), who selected one method most suitable for the stakeholders with few or no analytical skills.

IME also collaborated with the LUC Program in designing and implementation of downscaling and upscaling data harmonization procedures for estimating livestock production trends in China. The rescaling algorithms developed included the available information on economic, demographic, and resource constraints in specific locations, and data on agricultural inputs (e.g., fertilizers, irrigation, machinery, and labor). We dealt with the interpretation of incomplete or unobservable data by formulating corresponding optimization problems, in which estimations of unknown spatial distributions of values is properly represented by the criteria and constraints of the corresponding agricultural production planning model.

Moreover, IME in collaboration with the Land Use Change (LUC) Program integrated several methods and tools developed earlier for: 1) effective design and implementation of robust decisions for integrated management of endogenous uncertainties; and 2) multicriteria analysis. This activity was driven by the research of one of the 2008 participants in the Young Scientists Summer Program (YSSP) who needed these methods and tools for developing a model for management of a multipurpose reservoir.

Research by YSSP Participants

IME had in 2008 four YSSPers; all of them achieved very good results which provided a basis for peer-reviewed publications.

- Sayaka Kanata (from Kyoto University, Japan) researched decision-making support for control problems characterized by conflicting goals and inherent uncertainties for application to designing robust control of a space robot.
- Adam Kiczko (from Institute of Geophysics, Polish Academy of Sciences) developed a multicriteria decision support for multipurpose reservoir management focused on the protection of ecologically valuable areas of the Narew National Park.
- Shuo Liu (from Beihang University, China) worked on a catastrophe bond pricing model intended to form part of the decision support process for risk transfer strategy in China.
- Dongling Zhang (from the University of the Chinese Academy of Sciences) worked on data analysis (often also called data mining), and developed a new kernel-based estimation method. The method was successfully tested not only on the standard data-mining examples but also on problems researched at IIASA.

IME follows the proven tradition of keeping in contact with former YSSPers; therefore it is likely that at least some of them will collaborate with IIASA in the future.

Scientific Recognition

- Yuri Ermoliev was invited to give a keynote lecture on "Facets of robust decisions for global changes" at the conference "Statistics in Ukraine: Current Situation, Problems and Trends" organized by the State Statistics Committee of Ukraine; and an invited lecture (together with T. Ermolieva, M. Jonas, and M. Makowski) on "Robust emission trading schemes" a special session of the International Conference on Problems of Decision Making under Uncertainties, organized in cooperation with IIASA by a network of leading Ukrainian universities and institutes.
- Marek Makowski was invited to the Program Committees of two conferences: "IFIP (International Federation of Information Processing) WG 7.6" and "Decision Support in Telecommunications," where he gave lectures on "A service-based modeling environment for integrated problem analysis" and on "Reality check of wishful thinking on specification of preferences in multicriteria analysis," respectively.
- Yuri Ermoliev and Marek Makowski were invited to the Data Mining & Fusion Workshop organized by the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) with the leading experts on data mining. The invited lecture on "Selected Methods of Data Analysis and their Applications" was prepared by Tatiana Ermolieva (of the LUC Program) in collaboration with the former IME YSSPer Bartosz Kozłowski.
- Shuo Liu received a grant from the China Scholarship Council for a 2-year stay at IIASA as part of a joint PhD program set up by her home university and IIASA.
- Two former IME YSSPers received in 2008 PhDs for their thesis that included research carried out at IIASA, namely, Jennifer Walston, YSSPer 2006, from the Air Force Institute of Technology, USA, and Aron Larson, YSSPer 2007, from the Mid Sweden University.

Part V

Cross-Cutting Activities

Greenhouse Gas Initiative

Fabian Wagner
wagnerf@iiasa.ac.at

Objectives

The Greenhouse Gas Initiative (GGI) is the largest inter-program collaborative research effort at IIASA, and has been since its inception. It involves more than two dozen researchers from eight programs and aims to address questions critical to advancing scientific understanding and to informing policy processes related to the challenge of climate change. The Initiative takes as its context, inter alia, the ultimate goal of the UN Framework Convention on Climate Change (UNFCCC), namely, to stabilize atmospheric concentrations of greenhouse gases and thereby avoid dangerous impacts. However, GGI now also emphasizes the need for regional approaches that address not only mitigation or adaptation, but also sustainable development.

Scientific Achievements and Policy Impact

In 2008 GGI underwent a restructuring and reorientation of its research agenda. The main focus in 2008 was on regional climate change issues, with an emphasis on East Asia, particularly the south of the region: the short-term perspective, as well as both mitigation and adaptation strategies.

Specifically, research activities included: 1) a modeling exercise to assess the co-benefits of integrated nitrogen management with greenhouse gas mitigation and adaptation to climate change; 2) a robustness evaluation of adaptation options and strategies for extreme climate risks; 3) the involvement of adaptation in integrated climate-change modeling; and 4) the analysis of policy pathways to human development and implications for greenhouse gas (GHG) emissions.

Integrated Nitrogen Management in China: INMIC

Economic and demographic drivers continue to increase the demand for agricultural products in China. However, production expansion is constrained by limited land resources. As a consequence, an increase in environmental impacts must be expected.

In INMIC we developed a framework of indicators which allow these additional environmental impacts to be quantified as a function of the drivers and potential abatement measures. The framework combines elements from demand-driven agricultural modeling (LUC CATSEI model) and simulations of the fluxes to air and water (GAINS and MITERRA models, respectively). In the overall framework, the drivers and trends of agricultural intensification were used to compile indicators of leaching and release of nitrous oxide and ammonia into the environment in China. This allows the magnitude of environmental loads to be assessed under alternative demographic and other socioeconomic scenarios and policy suggestions to be provided on alternative pathways for mitigating or minimizing negative environmental and health risks from agriculture.

While the indicators provide a reasonable foundation for a comparison of opportunities for action, it must be recognized that some of the underlying technical parameters have been taken from European case studies. This means that the derived indicators will allow a trend and comparative advantage of alternative emission reduction strategies to be underlined, but not so much the absolute quantification of an emission flux.

The work described in this project presents merely a framework which can be used to test scenarios affecting agricultural activities and their related emissions. The framework has been set; further scenarios can be defined.

Adaptation to Extreme Climate Risks: ADAPT

The GGI ADAPT project addresses two of the most topical questions concerning climate-change adaptation in the policy and modeling communities, namely: What are robust options for adapting to climate change? and How can adaptation be taken into account in integrated climate-change modeling? Focusing on Indian states bordering India and Nepal, these interrelated questions are being investigated for the agricultural sector, which is already facing exposure to high risks from weather extremes. The project proposed focusing on a study site in Uttar Pradesh, India, with a related study on the neighboring region of Nepal (making use of available datasets and expertise) in order to derive important cross-country findings.

Task 1 aimed to quantify relationships between various socioeconomic variables and household- and national-level vulnerability to natural hazards and climate change. The first part of this task was a study of community-level vulnerability to natural hazards. The dataset used provided the basis for novel work examining social vulnerability. It enables us to assess lives lost, number of animals lost, and the number of families affected per year by flood and landslides to be regressed to levels of educational attainment at the level of the village development committee (VDC), economic status variable, population size, and indicator of physical vulnerability of each VDC. According to our analysis, the education level emerges as significant, even after other important co-variates are controlled for. The second part of the task examined the literature more generally and conducted a study of national-level vulnerability. We reassembled a global dataset based on country-level data on disaster losses and socioeconomic data. One result of this analysis was to specify a disaster "Kuznets curve" to a greater extent than done in the past, by showing the non-linear relationship between the human development index (HDI) of the UN Development Programme (UNDP) and disaster losses, after controlling for other driving forces of vulnerability.

Task 2 was concerned with developing a quantitative model approach and focused on refining the CATSIM Micro model for assessing the costs and benefits of adaptation of households to the vagaries of nature under additional climate change stress

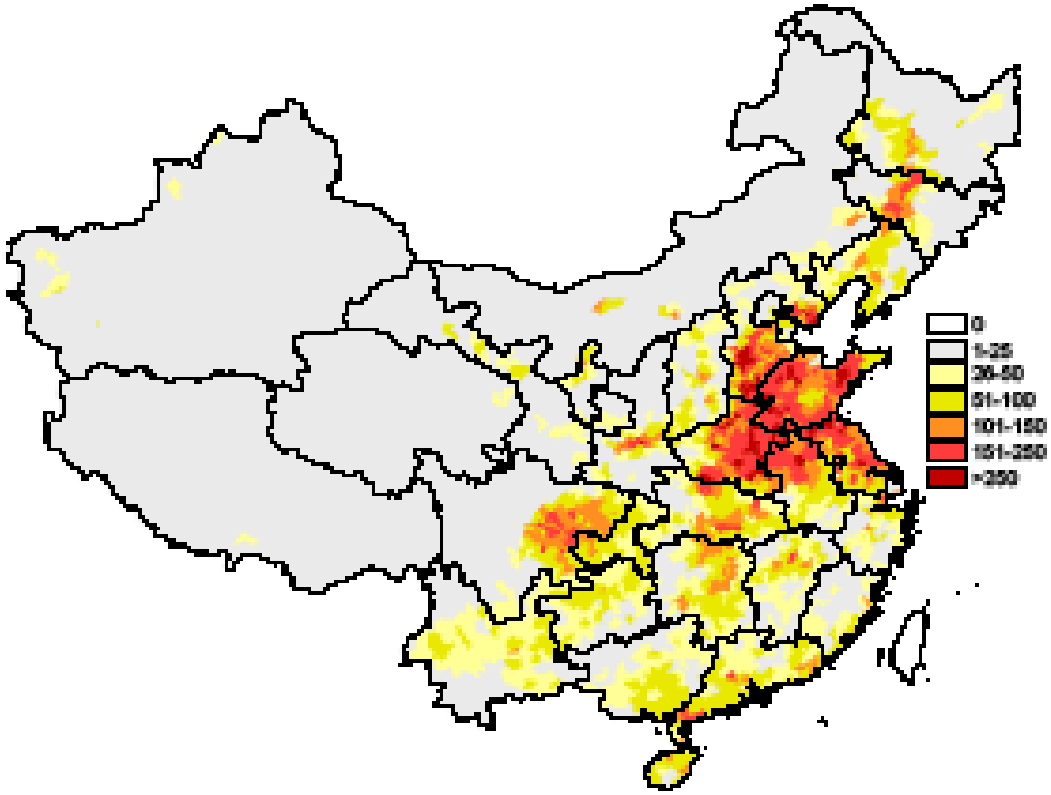


Figure 1. China: Intensity of nitrogen losses (kg nutrients/ha total land), central projection, 2030.

for the case of Uttar Pradesh in Northern India. The CATSIM framework was organized around a stochastic representation of the long-term economic welfare of a single household, based on the cycle of income (in terms of crop production), consumption (considering minimal caloric needs), debt, savings, and income-enhancing investment. The model (and representative household) was informed by our Uttar Pradesh survey, and through convolution is now able to simulate the combined probabilistic shocks of both floods and droughts. Projected climate change impacts on these hazards, estimated through the use of a statistical downscaling model, have also been incorporated. A key objective of the project was to make the role of education and demographic information more prominent in the model framework, which was achieved with the help of collaborators from the World Population Program (POP) and the Population and Climate Change Program (PCC). Overall, we are finding that disasters, through their impact on livelihoods, have the potential to trap farmers in poverty and that development assistance in the form of deliberate disaster risk management can return important benefits in terms of helping them escape the poverty trap. Further, integrated physical (e.g., irrigation) and financial (e.g., insurance) intervention packages return higher benefits at similar costs, if interventions targeted at higher (irrigation) and lower frequency events (insurance) are effectively combined.

Finally, Task 3 of this project compares the robustness and returns of investing in general development via agricultural extension services (vocational training) in terms of increasing farmer efficiency and risk management with deliberate disaster risk management and climate adaptation policies. It was originally envisioned that tasks 2 and 3 would also relate to the Nepal case, yet because of a lack of data and models (such as downscaled climate models, hydrological models, and detailed household-level information) we had to reconsider and focus the modeling framework on India.

The Human Development Index, Investments, and GHG Emissions (HDI)

Enhanced human development achieved through conventional pathways of economic growth implies increased consumption of natural resources and increased greenhouse gas emissions. This activity examines how human development—as measured through the UNDP Human Development Index—could be progressed through alternative investments that cause less of an increase in GHG emissions.

In this project we examined the sensitivity of a major index of human development, the UNDP HDI to interrelated policy interventions. Whether the HDI is a reliable index of human development or, for that matter, how human development ought to be defined, are not questions that concern this activity. While some have argued (e.g., Kelly, 1991) that the HDI offers only limited insights, we recognize that the HDI is now a pervasive index and one that resonates well with policymakers.

The policy question addressed is: "Which policy interventions (education, sanitation, pollution control, health care, etc.) would lead to equal progress in the HDI compared with a "conventional" increase in per capita income, while causing fewer GHG emissions?"

The project started only in the fall of 2008, and the objective for the first few months has been to focus on the impacts

of alternative investments on HDI in India at the national scale. In a first step, methodologies have been reviewed to estimate the potential impact, and the next steps will be to make the first quantitative estimates. In 2009 the analysis will focus on subsequent effects and their consequences for GHG emissions. Furthermore, the feasibility of an extension to other countries will be assessed.

Other Activities

A number of smaller scale activities have been continued from 2007, among them the further development of the myopic MESSAGE model that can be used to study the implications of interim mitigation targets. A paper on this will be presented at the Climate Congress in Copenhagen in March 2009. Also, at the beginning of 2008 a study assessing drivers of extreme event risks in Bangladesh was concluded.

As part of its objective, GGI organizes "special seminars" and "open forum discussions" on an ad hoc basis, sometimes in cooperation with other IIASA programs. The aim of these seminars is to provide IIASA researchers with a platform for discussing new ideas related to the broad topic of climate change on one hand and to benefit from the expertise of several external collaborators on the other. In 2008 GGI hosted 17 of these events, some of which had a specific UNFCCC focus, including seminars on the role of adaptation and the flexible mechanisms in the UNFCCC process; a climate change negotiation simulation game with participants in the Young Scientists Summer Program (YSSP) and staff; and a talk on uncertainty in GHG inventories and emissions trading. The other seminar topics ranged from "Parameter estimation for the climate system," through "Managing future energy demand: Role for energy efficiency," to "How about geo-engineering?" GGI also organized two review meetings, in which the ongoing research activities were discussed by a wider IIASA audience.

GGI researchers participated actively in the 14th Conference of Parties to the UNFCCC in Poznan (Poland) in December 2008 at various side events. Presenters included: Fabian Wagner, Tony Patt, Reinhard Mechler, and Hannes Boettcher. Other policy briefings included a presentation on methane mitigation opportunities at the Clean Air Task Force Policy meeting on Near-Term Strategies for Slowing Warming in the Arctic: Short-Term Pollutants and Arctic Warming, Copenhagen, Denmark (Wagner), and invited lectures at the Royal Geographical Society in London (Patt) and the Tällberg Forum, Tällberg, Sweden (Patt). Conference contributions were made, inter alia, by Reinhard Mechler at the "Natural Catastrophe Risk Insurance Mechanisms for Asia and the Pacific" conference in Tokyo, organized by the Asican Development Bank (ADB), Shonali Pachauri (The International Association for Energy Economics (IAEE) International Conference, Istanbul, Turkey; Institute of Social Ecology (IFF) Vienna), and Tony Patt (AdaptCRVA project kickoff conference, Trondheim, Norway).

Publications

In 2008 GGI researchers wrote or contributed to 13 peer-reviewed journal publications (another nine are in the process of being submitted, under review, or forthcoming), eight contributions to books, five IIASA Interim Reports (plus two in preparation), and several other reports. Details can be found in a separate list of publications. Tony Patt has been associate and co-editor of various journals, including *Climate and Development*, Pallav Purohit (APD) has been appointed Guest Editor for a Special Issue of *Sustainability* on air pollution and GHG mitigation, and Reinhard Mechler has been invited to be co-editor of the Special Issue on "Assessing Disaster Risk Management and Climate Adaptation" of the journal *Mitigation and Adaptation Strategies*.

Staff

After GGI co-leaders Markus Amann and Nabojsa Nakicenovic resigned from their positions in May 2008, Fabian Wagner (APD) was appointed interim coordinator by the interim director. GGI then self-organized and formed a new leadership group, including Fabian Wagner, Tony Patt (RAV), Shonali Pachauri (PCC/ENE), Reinhard Mechler (RAV), Sylvia Prieler (LUC), Hannes Boettcher (FOR), and K.C. Samir (POP), representing all research programs involved in GGI research this year. In 2008 more than 25 staff from eight different IIASA programs/projects contributed to GGI's research agenda.

Activities for 2009

Of the three research projects GGI initiated in 2008, two have been concluded according to plan by the beginning of 2009, while the project on the Human Development Index continues until the end of 2009. In addition, and in the bottom-up spirit of the initiative, GGI has made an Institute-wide call for research proposals for 2009 and received four proposals. At the time of writing it had not been decided which of those will be funded, given challenging resource constraints.

Part VI

Programs for Young Scientists

Young Scientists Summer Program

Mahendra Shah, Dean
shah@iiasa.ac.at

There were about 340 applicants to the Young Scientists Summer Program (YSSP) in 2008, of which 49 were selected from 22 countries from around the world. Since the beginning of the YSSP in the 1970s, a total of some 1,460 young scientists have successfully passed through the YSSP Program.

The YSSP team has continued its efforts to make this summer scientific program more interactive and interdisciplinary as well as policy-oriented. In 2008 five workshops were organized, each of three hours' duration. The themes of the workshops were selected in the context of the major challenges facing the world community in the 21st century. The first workshop, organized by **John Casti from Dynamic Systems (DYN)** and partnered by the Integrated Modeling Environment (IME) introduced the tools of systems analysis and modeling to the YSSPers, who had the opportunity during the discussion period to seek advice and information on their own specific modeling needs.

The second workshop on human wellbeing, coordinated by **Shonali Pachauri of Population and Climate Change (PCC)**, focused on issues of food security (LUC), education and human capital (POP), and human health (HGC), on which brief presentations were given by the Land Use Change (LUC), World Population Program (POP), and Health and Global Change (HGC) programs. Following the presentations by the four participating programs, the participating YSSPers were divided into three groups and discussed the issues of inter-linkage between the three theme areas as well as the interdisciplinarity between the issues and how policy could be guided in the real world.

The third workshop, coordinated by **Michael Obersteiner of Forestry (FOR)**, involved participants from the Air Pollution and Economic Development (APD), Evolution and Ecology (EEP) and Energy/Transition to New Technologies (ENE/TNT) programs. YSSPers were requested to prepare in advance specific issues of environment and natural resources hat were relevant to their summer project. This workshop also split the participants into four groups, each of which elaborated an environmental funding proposal focusing on issues of integrating remote sensing data with on-the-ground and household surveys.

The theme of the fourth workshop, coordinated by **Fabian Wagner of the Greenhouse Gas Initiative (GGI)** focused on international climate change negotiations in the real world. The workshop began with a panel discussion by members of GGI, Risk and Vulnerability (RAV), DYN, and Processes of International Negotiation (PIN). Following this, a roundtable format was used to conduct negotiations on climate change, with workshop participants taking policy positions that were representative of real-world negotiations.

The fifth workshop, **coordinated by Alex Pang and Jane McDonald of the Institute for the Future (IFTF) and IIASA**, lasted a full day; its subject was Global Science and Technology. All participants came with their laptops which were interconnected with IFTF's Future X Project. At the end of the workshop the discussion highlighted the importance of diversity and interdisciplinary issues in the context of innovations and technological progress and the future of science.

In addition to the above five workshops, three seminars were organized as follows:

Trends in Emerging Technologies: Energy, Environment and Development (Kenneth Oye, Massachusetts Institute of Technology), Methods and Tools for Integrated Sustainability Assessment (Jill Jäger, MATISSE), and Globalization and Equity: Kicking away the ladder (Ha Joon Chang, Cambridge University). Mahendra Shah also gave the Dean's seminar on Sustainable Development—From Agenda Setting to Policy Actions.

The YSSPers also organized a seminar on issues of climate change and extreme events. Monika Swahney (POP YSSPer) showed a film "when the levees broke," which was followed by lively discussion on the need for pre-, during, and post phases of extreme events. The discussion particularly highlighted the failure of emergency services in the USA during and in the aftermath of the hurricane.

The YSSPers, as well as IIASA staff, were asked to fill out review questionnaire on their experiences of the YSSP 2008. These results were summarized and shared with the Internal Research Committee (IRC) members and IIASA staff. This feedback is important in shaping and focusing the YSSP summer program in order to give YSSPers insights into the need for systems analysis and modeling to match applied science to policy actions.

Postdoctoral Program

Barbara Hauser, Coordinator
hauser@iiasa.ac.at

Postdoctoral research opportunities continued to expand at IIASA during 2008 through the following scholarships and grants:

- IIASA Postdoctoral Program
- Kempe Foundation, Sweden
- Academy of Finland
- External grants awarded to IIASA's research programs

Postdoctoral fellows have the opportunity to pursue their own research interests at IIASA on topics related to IIASA's core themes. The 12–24 months' scholarships carry special recognition both within and outside the Institute.

The chance to work in a rich international scientific environment alongside scientists from over 30 countries and disciplines, as well as to experience IIASA's multidisciplinary approach to real-world problems, results in a lively and challenging postdoctoral environment. The international, interdisciplinary research environment is clearly recognized by the postdoctoral fellows as one of the main professional benefits to be gained at IIASA and gives them the unique experience of being able to work with multidisciplinary teams. As one fellow remarked, "one of the advantages of being at IIASA is to learn to communicate with colleagues of completely different backgrounds and discover new angles to work on common problems."

Jason Blackstock and **Jacob Johansson** received the two 2008 IIASA-funded postdoctoral positions. Blackstock joined the RAV program where he is focusing on evaluating the scientific, political, and economic implications of climate engineering (geoengineering) concepts aimed at limiting the negative consequences of climate change caused by greenhouse gas emissions. Johansson took up his appointment in the EEP program where he is developing eco-evolutionary models for explaining fundamental patterns of variation in plant community structures. The project is a part of an international collaborative effort to create a new generation of evolutionarily informed vegetation models for predicting responses to global climatic trends.

Terence Fell, **Erling Lundevaller**, and **Johan Östergren** were the recipients of the 2008 postdoctoral scholarships funded by the Swedish Kempe Foundation. Fell is working with the Forestry Program, looking into the analysis of forestry management's institutional performance in local community settings. Lundevaller is focusing on methods for demographic projections within the World Population Program and Östergren joined the EEP program to look into eco-genetic modeling of human-induced evolution (i.e., dams and fisheries) in anadromous fish in general, with a particular focus on sea trout.

In total, IIASA had 17 postdoctoral fellows in permanent residence at IIASA during 2008.

Part VII

Appendices

Communications

Iain Stewart
stewart@iiasa.ac.at

Objectives

IIASA established a new Communications (COM) Department in March 2008 to help position IIASA as a leading global research organization dealing with environmental, economic, technological, and social change. The aims of the new department are:

1. Raising awareness of IIASA's objectives and impact, and building positive perceptions of IIASA among external target audiences;
2. Supporting the development of new and existing partnerships (funders, researchers, policymakers);
3. Bringing attention to and fostering research opportunities;
4. Supporting the communication activities of IIASA scientists; and
5. Developing an internal environment that encourages IIASA scientists to communicate.

Activities in 2008

During 2008 COM focused on developing the communication channels to its target audiences in collaboration with relevant IIASA programs and departments.

IIASA's key external audiences are:

1. NMOs and potential NMOs (with Directorate [DIR]);
2. Scientific community including young researchers (with Research Programs);
3. Policymakers (national and international) (with Research Programs);
4. Diplomatic community (with DIR);
5. Media and general public (with DIR and Research Programs);
6. Funding community (with Office of Sponsored Research [OSR]); and
7. Alumni (with OSR and IIASA Society).

NMOs

Objective: To raise awareness of, support for, involvement of, and commitment to IIASA, such that NMOs can be ambassadors for the Institute in their home countries. To this end, COM:

- Produced the Annual Report 2007, the Progress Report 2007, and a revised IIASA Charter;
- Organized various high-level meetings including IIASA Council, IIASA Science Advisory Committee, Retreat for new NMOs, EU Ambassadors at IIASA, IIASA Energy Day in Poland;
- Distributed new IIASA publications, press releases, and other communication materials (e.g., YSSP flyer and posters, Postdoc flyer and posters) to NMOs;
- Supported the DIR in the strategic planning process; and
- Developed a standard IIASA PowerPoint presentation (in progress)

Scientific Community

Objective: To raise awareness, support, involvement, and commitment such that IIASA is recognized for its world-class science and teams of scientists; and as an employer of choice. With this in mind, COM:

Selected publications: IIASA Charter, Annual Report (left); Negotiated Risks, Lung Health in Rural Nepal (center); Options, PinPoints (left)

- Produced IIASA books (*Negotiated Risks* [PIN], *Technological Innovation across Nations* [Watanabe]) to be published in 2009;
- Produced IIASA Research Reports (*Lung Health in Rural Nepal* [POP]);
- Published 38 IIASA Interim Reports;
- Produced two issues of IIASA's magazine *Options* and three newsletters for research programs (*PinPoints* [x2], *POPNET*);
- Produced a range of branded material for YSSPers including the handbook: YSSP calendar, directory, YSSP certificates, material for YSSP Awards Dinner;
- Produced IIASA Postdoc flyer, poster, and new Web site;
- Produced six podcasts; and
- Produced video summary of the IIASA Conference 2007.

Policymakers and Diplomatic Community

Objective: To raise awareness, support, involvement, and commitment such that policymakers view IIASA as a reliable source of high-quality, neutral research on international issues. Activities included:

- Launching a new series of IIASA publications, namely, IIASA policy briefs;
- Working closely with APD Program to communicate its new scientific model, GAINS, to policymakers by producing a brochure on the model, developing a range of branded materials, generating positive press coverage, and redesigning the APD Program's Web site;
- Increased interaction with communication teams in relevant national and international organizations (e.g. United Nations Communications Group in Vienna);
- Announcements to the diplomatic community in Vienna regarding the changing leadership at IIASA; and
- Organization of a meeting for EU ambassadors at IIASA.

All Audiences Including General Public and Media

Objective: To raise awareness of IIASA. Activities included:

- Production of *Options* (June, November);
- Organization of the Koopmans lecture by Sir John Beddington in Vienna which was attended by 150 senior diplomats, scientists, and policymakers from the Austrian government and international organizations;
- Establishment of a new IIASA Press Office, improvement of IIASA's media database, including media in NMO countries, issuing of 10 press releases;
- Production of brochures on IIASA research: GAINS-ASIA, Fragility of Critical Infrastructures;
- Development of IIASA's Web site, which included increasing the visibility of IIASA's research through more "new research"; announcements on the front page, adding new sections on the Nobel Prize, Awards, Climate Change Conference at Poznan; and
- Preparations for the redesign of IIASA's Web site by running a Web site survey, running focus groups with Web users, and investigating external Web design agencies.

Supporting the Communication Activities of IIASA Scientists

COM provided a range of services to support IIASA scientists. These included: English language editing; science writing; graphic design; conference services; publication production; negotiation with book publishers; printing; and maintaining publication lists and mailing lists.

COM also supported communication efforts of IIASA scientists that help IIASA achieve its key objectives by:

- Professionally managing IIASA's Web site and helping programs improve their Web sites;

IIASA Polich Briefs

- Running a proactive and reactive press office; and
- Advising scientists on communication strategy and providing specialized support to implement communication tactics from podcasts to media training.

Activities in 2009

In 2009 COM will continue to develop the above-mentioned communication channels. It will build on this approach following the launch of IIASA's new research strategy by developing a communications strategy that supports the new strategic plan. Other activities will include:

- Redesigning IIASA's Web site to reflect IIASA's new strategy;
- Promoting the Institute's climate change research in the run up to the UN Climate Change conference in Copenhagen in December 2009;
- Launching an e-newsletter;
- Publishing a popular science book; and
- Developing a communications toolkit to support and encourage IIASA scientists to communicate their work to wider audiences outside academia.

Performance Indicators for 2008

Readership of many IIASA publications continued to increase with the circulation of Options reaching over 6,000; IIASA Annual Report over 3,000; PINPoints over 3,000; and POPNET over 2,500.

IIASA Policy Briefs were launched in 2008 and the first four briefs were distributed to over 7,500 readers. Feedback was positive, for example:

"I do not know how I got a place in your mailing list, but the material sent is really interesting and meaningful."

Rajbir Singh, Ministry of Environment & Forests, New Delhi, India

"Mr Barroso received this policy brief with interest and has taken note of its contents."

Matthew Baldwin, Office of the President, European Commission

"While the research results are good and convincing, my main concern is how to translate them into actions. Kindly send to me extra copies, if available, of the policy brief for distribution to my colleagues at ECA."

Hassan Musa Yousif, United Nations Economic Commission for Africa, Ethiopia

Media coverage increased significantly in 2008 by 105 percent from 190 hits (in 21 countries) in 2007 to 390 hits (in 28 countries) in 2008. The increase continues with already 290 hits (36 countries) between January and April 2009.

Visitors to IIASA's Web site rose by 8 percent from 154,139 in 2007 to 166,769 in 2008. IIASA's Podcasts again proved highly popular with downloads increasing by 82 percent from 4163 in 2007 to 7468 in 2008.

Contracts, Grants, and Donations

- Austrian Conference on Spatial Planning, Vienna, Austria
- Austrian Development Agency, Vienna, Austria
- Austrian Exchange Service, Vienna, Austria
- Austrian Research Promotion Agency, Vienna, Austria
- Austrian Science Fund, Vienna, Austria
- City of Vienna, Cultural Department, Science and Research Promotion, Vienna, Austria
- Federal Ministry for Education, Science and Culture, Vienna, Austria
- Federal Ministry for Science and Research, Vienna, Austria
- MERIT Consulting and Brokerage, Vienna, Austria
- Vienna Institute for Demography, Vienna, Austria
- Vienna Science and Technology Fund, Vienna, Austria
- Petroleo Brasileiro S.A., Rio de Janeiro, Brazil
- European Science Foundation, Strasbourg, France
- The European Space Agency, Paris, France
- Carl von Ossietzky University, Oldenburg, Germany
- Forschungsverbund Berlin e.V., Berlin, Germany
- Friedrich Schiller University Jena, Jena, Germany
- Potsdam Institute for Climate Impact Research, Potsdam, Germany
- All India Disaster Mitigation Institute, Ahemdabad, India
- Ministry for the Environment and Territory, Rome, Italy
- Acid Deposition and Oxidant Research Center, Niigata, Japan
- Kyoto University, Kyoto, Japan
- Tokyo Electric Power Company, Tokyo, Japan
- Toyota Central Research & Development Laboratories, Inc., Aichi, Japan
- Toyota Motor Corporation, Aichi, Japan
- Korea Science and Engineering Foundation, Daejeon-City, Republic of Korea
- European Climate Foundation, Den Haag, Netherlands
- Netherlands Environmental Assessment Agency, Bilthoven, Netherlands
- Norwegian Meteorological Institute, Oslo, Norway
- ENIPPF Ltd., Moscow, Russia
- Institute for Energy and Finance, Moscow, Russia
- Russian Academy of Sciences, Moscow, Russia
- Royal Swedish Academy of Agriculture and Forestry, Stockholm, Sweden
- Swedish Environmental Research Institute Ltd, IVL, Goeteborg, Sweden
- Swedish Meteorological and Hydrological Institute, Norrkoeping, Sweden
- The Royal Swedish Academy of Agriculture and Forestry, Stockholm, Sweden
- The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning, Stockholm, Sweden
- Department for International Development, London, United Kingdom
- Entec UK Ltd, Newcastle, United Kingdom
- Imperial College of Science, Technology and Medicine, London, United Kingdom
- Manchester Metropolitan University, Manchester, United Kingdom
- University of Bristol, Bristol, United Kingdom
- CATF – Clean Air Task Force, Boston, MA, USA
- Forest Trends, Washington, DC, USA
- Harvard Business School, Boston, USA
- National Academy of Sciences, Washington, DC, USA
- National Aeronautics and Space Administration, Washington, DC, USA
- Smith Richardson Foundation, Inc, Greensboro, USA
- United States Environmental Protection Agency, Washington DC, USA
- United States Institute of Peace, Washington, DC, USA
- Department for International Development, London, United Kingdom
- Entec UK Ltd, Newcastle, United Kingdom
- Imperial College of Science, Technology and Medicine, London, United Kingdom
- The Manchester Metropolitan University, Manchester, United Kingdom
- University of Bristol, Bristol, United Kingdom
- European Commission, DG Agriculture & Rural Development, Brussels, Belgium
- European Commission, DG Environment, Brussels, Belgium
- European Commission, DG Environment, LIFE, Brussels, Belgium
- European Commission, DG Fisheries and Maritime Affairs, Brussels, Belgium
- European Commission, DG Research, Brussels, Belgium
- European Commission, Intelligent Energy Executive Agency, Brussels, Belgium
- European Commission – Joint Research Centre, Ispra (VA), Italy
- OPEC Fund for International Development, Vienna, Austria
- European Science Foundation, Strasbourg, France
- European Space Agency, Paris, France
- Food and Agriculture Organization of the United Nations, Rome, Italy
- European Climate Foundation, Den Haag, Netherlands
- The World Bank, Washington DC, USA

2008 Scientific Meetings, Sponsored or Co-Sponsored by IIASA

ADAM A2 Meeting
17–18 January
Risk and Vulnerability

Second Meeting of the ICES Study Group on Fisheries-Induced Adaptive Change [SGFIAC]
20–27 January (held in Copenhagen, Denmark)
Evolution and Ecology

A Systems Analysis Approach to Health and Wellbeing in the Urban Environment
23–26 January
Health and Global Change

ALICE Meeting
1 February
Risk and Vulnerability

Global Energy Assessment Executive Committee
February 03–05
Global Energy Assessment

SCENES Inter-Workpackage Meeting
6–8 February
Risk and Vulnerability

QUARTERMASS/QUEST Project Workshop
6–7 February
Forestry

PIN Roadshow, Geneva
11 February (held in Geneva, Switzerland)
Processes of International Negotiation

PIN Steering Committee Meeting
12–13 February (held in Geneva, Switzerland)
Processes of International Negotiation

10th Workshop on the Model Intercomparison Study in Asia (MICS-Asia)
18–19 February
Atmospheric Pollution and Economic Development

Young Scientists Winter Symposium
21–22 February
Young Scientists Summer Program

Disaster Risk Management in Madagascar Workshop
26–28 February
Risk and Vulnerability

Director Search Committee Meeting and Candidate Interviews
12–14 March
Directorate

Vulnerability and Opportunity of Methane Hydrates Workshop
13–14 March
Transitions to New Technologies

NEEDS RS2b meeting
13–14 March
Integrated Modeling Environment

Task workshop on Management of fisheries-induced adaptive changes; in the framework of the European Research Training Network FishACE
25–28 March (held in Maastricht, Netherlands)
Evolution and Ecology

1st Meeting of the Network for National Integrated Assessment Modelling (NIAM)
2–3 April
Atmospheric Pollution and Economic Development

LIFE III–EC4MACS Annual Project Meeting
3–4 April
Atmospheric Pollution and Economic Development

Symposium & Workshop: Towards an Evolutionary Ecology Vegetation Model (EEVM)
7–18 April (held in Sydney, Australia)
Evolution and Ecology

Science Advisory Committee (SAC) Meeting
10–11 April
Directorate

Enviro-RISKS Workshop
18 April
Forestry

Global Energy Assessment Knowledge Module (18) Working Group Meeting on Urbanization
24–25 April
Transitions to New Technologies

IIASA DAYS IN REPUBLIC OF KOREA
27–29 April (held in Seoul, Republic of Korea)
Council and External Relations

Second Phase of IIASA-TITech Collaboration–Mini-Workshop on "Hybrid Management in the 21st Century
1–2 May
General Research

Global Energy Assessment Executive Committee
5–6 May
Global Energy Assessment

Course on Advanced Large Scale GAMS Modeling with an Emphasis on Agriculture, Forestry and the Environment
5–8 May
Forestry

UN CSD-16 Side Event: Food Security and Sustainable Agriculture–The Challenges of Climate Change in Sub-Saharan Africa
8 May (held in New York, NY, USA)
General Research

2008 Steering Committee Meeting of the European Networking Programme FroSpects (Frontiers of Speciation Research)
12 May (held in Strasbourg, France)
Evolution and Ecology

Council Meeting
26–27 May
Directorate

Global Energy Assessment Knowledge Module (25) Working Group Meeting on Technology
26–27 May
Transitions to New Technologies

GEA Council Meeting
28–29 May (held in Lund, Sweden)
Global Energy Assessment

IIASA Day in Poland
10 June (held in Warsaw, Poland)
Council and External Relations

A Systems Analysis Approach to Health and Wellbeing in the Urban Environment–2nd planning meeting
17–19 June
Health and Global Change

CC-TAME Kick-off
18–19 June
Forestry

Theorists Meet Practitioners
20 June
Processes of International Negotiation

External Efforts to Promote Negotiation in Internal Identity Conflicts
21–22 June
Processes of International Negotiation

PIN Steering Committee Meeting
23–24 June
Processes of International Negotiation

GEO-BENE Progress Meeting 08
23–24 June
Forestry

French Embassy Briefing of Pan-EU Ambassadors in Vienna due to French EU Presidency (July–December 2008)
3 July
Directorate

Editorial meeting for joint work on EEP's "Fisheries-induced Adaptive Change" book
4– 8 August
Evolution and Ecology

The Economics of Technologies to Combat Global Warming
4–5 August (held in Snowmass, CO, USA)
Transitions to New Technologies

Evolving Fish, Changing Fisheries–Symposium to be held at the Annual Meeting of the American Fisheries Society (AFS)
17–21 August (held in Ottawa, Canada)
Evolution and Ecology

Project start-up meeting for a Swedish–Russian project with APD
19 August
Atmospheric Pollution and Economic Development

EUCAARI Meeting
29 August
Atmospheric Pollution and Economic Development

IDRiM Workshop on Integration and Multidisciplinarity
1–2 (September held in Varese, Italy)
Risk and Vulnerability

2nd Phase: 2nd IIASA-Tokyotech Workshop on "Hybrid Management in the 21st Century"
6–7 September
General Research

Global Energy Assessment Executive Committee
10–12 September
Global Energy Assessment

Integrated Assessment Modeling Consortium (IAMC) Meeting
22–23 September (held in Baden, Austria)
Energy

Working Subgroup Meeting of the Integrated Assessment Modeling Consortium (IAMC) Meeting and EMF (Energy Modeling Forum) Working Group on Transitions
24 September
Transitions to New Technologies

EMF (Energy Modeling Forum) Working Group Meeting
25–26 September
Energy

3rd Caspian Dialog (2008)
1–4 October (held in Almaty, Kazakhstan)
Processes of International Negotiation

Global Energy Assessment Knowledge Module (18) Working Group Meeting on Urbanization
1–2 October (held in New York, NY, USA)
Global Energy Assessment

NMO Retreat
6–7October
Directorate

Science Advisory Committee (SAC) Meeting
16–17 October
Directorate

Applications of Dynamic Systems to Economic Growth with Environment
7–8 November
Dynamic Systems

QUEST-QUATERMASS Internal Workshop "From Case Studies to Global Modeling 2"
10–11 November
Forestry

Council Meeting
17–18 November
Directorate

EU-Mena Workshop
24–27 November
Risk and Vulnerability

Discontinuities in Complex Adaptation Systems
24–25 November
Risk and Vulnerability

Strategic Planning Workshop
24–25 November
Directorate

The IIASA Koopmans Lecture by Professor John Beddington on Science and Innovation in the 21st Century
28 November (held in Vienna, Austria)
Directorate

Effects of Migration on Population Structures in Europe
1–2 December (held in Vienna, Austria)
World Population

Global Energy Assessment Knowledge Module (10) Working Group Meeting on Energy End-Use (Efficiency): Buildings
4–5 December
Global Energy Assessment

Global Energy Assessment Knowledge Module (24) Working Group Meeting on Innovation
8–10 December (held in Cambridge, MA, USA)
Global Energy Assessment

PIN Roadshow Warsaw
10 December (held in Warsaw, Poland)
Processes of International Negotiation

PIN Steering Committee Meeting
11–12 December (held in Warsaw, Poland)
Processes of International Negotiation

Strategic Planning Workshop II
15–18 December
Directorate

Population Dynamical Consequences of Harvesting-induced Adaptive Evolution
15–17 December (held in Båstad, Sweden)
Evolution and Ecology

2008 IIASA Guest Lectures

January – March

- 18 January 2008, **Tae-Soo Chon**, Division of Biological Sciences, Pusan National University, Busan, Republic of Korea, "Disturbance Monitoring: From Communities to Behaviors"
- 27 February 2008, **Barry Kellman**, Director, International Weapons Control Center, and Professor of International Law, DePaul University, Chicago, "Threats of Man-Made Pandemic Disease – Need for Applied Systems Analysis"
- 18 March 2008, **Alan McKane**, University of Manchester, "Fixation and Consensus Times on a Network: A Unified Approach"

April – June

- 11 April 2008, **David Lane**, University of Modena and Reggio Emilia, and Santa Fe Institute, "Is Innovation Infrastructure Sustainable?"
- 14 April 2008, **Linda See**, School of Geography, University of Leeds, "Neutral Networks: An Overview and Applications in Flood Forecasting"
- 17 April 2008, **Peter Duinker**, School for Resource and Environmental Studies Faculty of Management, Dalhousie University, Halifax, Canada, "Scenario Analysis for Understanding Forest Policy: Experiences with European and Canadian Forests"
- 21 April 2008, **Harald Katzmair**, Founder and Director, Network Analysis for Science and Business Research, "Classifying and Evaluation (social) Networks"
- 29 May 2008, **Olof Leimar**, Department of Zoology, Stockholm University, "Species Packing"
- 30 May 2008, **Jörgen Ripa**, Lund University, Sweden, "Adaptive Dynamics in Stochastic Environments"
- 4 June 2008, **Jayant A. Sathaye**, Lawrence Berkeley National Laboratory, University of California, Berkeley, "Managing Future Energy Demand: Role for Energy Efficiency"
- 4 June 2008, **Rangan Banerjee**, Energy Systems Engineering, Indian Institute of Technology, Bombay, "Renewable Power Generation in India: Establishing Feasible Targets"
- 9 June 2008, **Claus Rueffler**, Faculty of Mathematics, University of Vienna, "Bet-hedging or Phenotypic Plasticity: What is Better in a Stochastically Varying Environment?"
- 12 June 2008, **Lise Marty**, Laboratoire Ressources Halieutiques, French Research Institute for Exploitation of the Sea, Port-en-Bessin, France, "Effects of Growth and Mortality on the Evolution of Maturation Reaction Norms"
- 26 June 2008, **Ken Haste Andersen**, AQUA – National Institute of Aquatic Resources, Technical University of Denmark, "Size Structured Models of Marine Fish Communities"

July – September

- 3 July 2008, **Agnes Rettelbach**, Max F. Perutz Laboratories, University of Vienna, "Effects of Genetic Architecture on the Evolution of Assortative Mating under Frequency Dependent Disruptive Selection"
- 9 July 2008, **Alan Meier**, Senior Scientist, Lawrence Berkeley National Laboratory, "Principal Agent Problems and the Demand for Energy"
- 14 July 2008, **Suam Kim**, Pukyong National University, Busan, Republic of Korea, "Environmental Variability and its Effects on Fish Resources in the Northwestern Pacific Ecosystem"
- 14 July 2008, **Fabio Dercole**, Politecnico di Milano, Milan, Italy, "Consequences of Technology Innovation on Fisheries Resilience: The Point of View of Adaptive Dynamics"
- 16 July 2008, **Richard Klein**, Stockholm Environment Institute (SEI), "Adaptation and the UNFCCC"
- 29 July 2009, **Gennady Matishov**, Southern Scientific Centre, Russian Academy of Sciences, Rostov-on-Don, Russia, "Key Directions of Basic Science in the Southern Region of Russia (results and tasks)"
- 31 July 2008, **A. Sonntag** and **U. Schubert**, Institute for Regional Development and Environment, Vienna University of Economics and Business Administration, "Input-Output-Analysis as a Holistic Approach to Evaluate and Rank Energy Policy Actions"
- 28 August 2008, **Mikhail Malioutov**, Department of Mathematics, Northeastern University, "Context-free Attribution of Text Authorship: A Review"
- 1 September 2008, **Serguei Kaniovski**, Austrian Institute of Economic Research (WIFO), "Probabilistic Aggregation of Correlated Dichotomous Choice with Applications to Decision-making in Groups"
- 25 September 2008, **Tamara Münkemüller**, Department of Ecological Modelling, Helmholtz Centre for Environmental Research – UFZ, Leipzig, Germany, "Hutchinson Revisited: Variability in the Mechanisms of Density Regulation Facilitates Species Coexistence"

October – December

- 15 October 2008, **John E. Tilton**, Visiting Professor, Institute for Environmental Decisions (IED) Natural and Social Science Interface (NSSI) , ETH Zurich, "China's Impact on Global Markets for Mineral Commodities"
- 31 October 2008, **Tae-Soo Chon**, Division of Biological Sciences, Pusan Natinal University, Busan, Republic of Korea, "Species Abundance Patterns in Benthic Macroinvertebrate Communities in Response to Disturbances in Streams"
- 31 October 2008, **Jin-Yeong Kim**, Coastal and Offshore Fisheries Resources Division, National Fisheries Research and Development Institute (NFRDI), Busan, Republic of Korea, "Population Variation of Sardine (*Sardinops melanosticta*) in Korean Waters, in Relation with Climate Change and Fishing"
- 3 November 2008, **Vasileios Dakos**, Aquatic Ecology and Water Quality Management, Wageningen University, "Aquatic Ecology & Water Quality Management"

- 7 November 2008, **Derrick Moot**, Lincoln University, Canterbury, New Zealand, "Adaptation in New Zealand: Past, Present and Future"
- 11 November 2008, **Alexander Slaski**, Program on Energy and Sustainable Development (PESD), Stanford University, "Transition from Traditional Biomass to Modern Energy Sources"
- 28 November 2008, **John Beddington**, UK Government Chief Scientific Adviser, "Science and Innovation in the 21st Century"

2008 IIASA Publications, by Research Program

Atmospheric Pollution and Economic Development (APD)

Journal Articles (Peer-Reviewed)

Birmili W, Alaviippola B, Hinneburg D, Knoth O, Tuch T, Kleefeld-Borken J & Schacht A (2008). Dispersion of traffic-related exhaust particles near the Berlin urban motorway: Estimation of fleet emission factors. *Atmospheric Chemistry and Physics Discussions*, 8(4):15537–15594.

Crutzen PJ, Mosier AR, Smith KA & Winiwarter W (2008). N_2O release from agro-biofuel production negates global warming reduction by replacing fossil fuels. *Atmospheric Chemistry and Physics*, 8(2):389–395. (GGI)

Han Z, Sakurai T, Ueda H, Carmichael GR, Streets D, Hayami H, Wang Z, Thongboonchoo N, Engardt M, Bennet C, Fung C, Park SU, Kajino M, Sartelet K, Matsuda K & Amann M (2008). MICS-Asia II: Model intercomparison and evaluation of ozone and relevant species. *Atmospheric Environment*, 42(15):3491–3509.

Hayami H, Sakurai T, Han Z, Ueda H, Carmichael GR, Streets D, Holloway T, Wang Z, Thongboonchoo N, Engardt M, Bennet C, Fung C, Chang A, Park SU, Kajino M, Sartelet K, Matsuda K & Amann M (2008). MICS-Asia II: Model intercomparison and evaluation of particulate sulfate, nitrate and ammonium. *Atmospheric Environment*, 42(15):3510–3527.

Holloway T, Sakurai T, Han Z, Ehlers S, Spak SN, Horowitz LW, Carmichael GR, Streets D, Hozumi Y, Ueda H, Park SU, Fung C, Kajino M, Thongboonchoo N, Engardt M, Bennet C, Hayami H, Sartelet K, Wang Z, Matsuda K & Amann M (2008). MICS-Asia II: Impact of global emissions on regional air quality in Asia. *Atmospheric Environment*, 42(15):3543–3561.

Purohit I & Purohit P (2008). Effect of instrumentation error on the first and second figures of merit (F1 and F2) of a box-type solar cooker. *International Journal of Ambient Energy*, 29(2):83–92.

Purohit P (2008). Small hydro power projects under clean development mechanism in India: A preliminary assessment. *Energy Policy*, 36(6):2000–2015.

Purohit P & Michaelowa A (2008). CDM potential of solar water heating systems in India. *Solar Energy*, 82(9):799–811.

Shindell D, Lamarque J-F, Unger N, Koch D, Faluvegi G, Bauer S, Amann M, Cofala J & Teich H (2008). Climate forcing and air quality change due to regional emissions reductions by economic sector. *Atmospheric Chemistry and Physics*, 8(23):7101–7113.

Viana M, Kuhlbusch TAJ, Querol X, Alastuey A, Harrison RM, Hopke PK, Winiwarter W, Vallius M, Szidat S, Prevot ASH, Hueglin C, Bloemen H, Wahlin P, Zecchi R, Kasper-Giebl A, Maenhaut W & Hitzenberger R (2008). Source apportionment of particulate matter in Europe: A review of methods and results. *Aerosol Science*, 39(10):827–849.

Wang Z, Xie F, Sakurai T, Han Z, Carmichael GR, Streets D, Engardt M, Holloway T, Hayami H, Kajino M, Thongboonchoo N, Bennet C, Park SU, Fung C, Chang A, Sartelet K & Amann M (2008). MICS-Asia II: Model inter-comparison and evaluation of acid deposition. *Atmospheric Environment*, 42(15):3528–3542.

Wei W, Wang S, Chatani S, Klimont Z, Cofala J & Hao J (2008). Emission and speciation of non-methane volatile organic compounds from anthropogenic sources in China. *Atmospheric Environment*, 42(20):4976–4988.

Other Publications (Non-Peer-Reviewed)

Amann M & Wagner F (2008). Clean air in Asia. Options; IIASA, Laxenburg, Austria, pp. 12–13.

Klimont Z & Winiwarter W (2008). 100 years of ammonia synthesis. Options; IIASA, Laxenburg, Austria p. 10. (GGI)

Interim Reports (Non-Peer-Reviewed)

Pivovarchuk D (2008). Consistency Between Long-term Climate Target and Short-term Abatement Policy. Attainability Analysis Technique. IIASA Interim Report IR-08-017. (GGI, DYN)

Dynamic Systems (DYN)

Journal Articles (Peer-Reviewed)

Aseev SM & Kryazhimskiy AV (2008). On a class of optimal control problems arising in mathematical economics. *Proceedings of the Steklov Institute of Mathematics*, 262(1):10–25.

Aseev SM & Kryazhimskiy AV (2008). Shadow prices in infinite-horizon optimal control problems with dominating discounts. *Applied Mathematics and Computation*, 204(2):519–531.

Brigolin D, Davydov AA, Pastres R & Petrenko I (2008). Optimization of shellfish production carrying capacity at a farm scale. *Applied Mathematics and Computation*, 204(2):532–540.

Davydov AA & Komarov MA (2008). Local controllability bifurcations in families of bidynamical systems on the plane. *Proceedings of the Steklov Institute of Mathematics*, 261:84–93.

Davydov AA & Kukshina EO (2008). Typical profit singularities of one-parametric cyclic process with fixed period. *Optimization*, 2(2):1–10.

Fukuda K & Watanabe C (2008). Japanese and US perspectives on the National Innovation Ecosystem. *Technology in Society*, 30(1):49–63. (GEN)

Krasovskii AA, Tarasyev AM (2008). Mathematical models of economic growth. *Vestnik of the Liberal Arts University, Ekaterinburg*, 1(8): 109-136 [in Russian].

Kryazhimskiy AV & Maksimov VI (2008). On rough inversion of a dynamical system with a disturbance. *Inverse and Ill-Posed Problems*, 16(6):587–600.

Kryazhimskiy AV, Obersteiner M & Smirnov A (2008). Infinite-horizon dynamic programming and application to management of economies effected by random natural hazards. *Applied Mathematics and Computation*, 204(2):609–620. (FOR)

Minullin,Y. Queuing to China's gas market. *The Oil of Russia Journal*, 5:104–108 (in Russian).

Minullin,Y. Whose pipeline will go East? *The Oil of Russia Journal*, 3:106–109 (in Russian).

Swanack TM, Grant WE & Fath BD (2008). On the use of multi-species NK models to explore ecosystem development. *Ecological Modelling*, 218(3–4):367–374.

Book Chapters (Peer-Reviewed)

Casti JL & Fath BD (2008). Ecological complexity. In: Jorgenssen SE & Fath BD (eds), *Encyclopedia of Ecology*. Elsevier, Amsterdam, The Netherlands, pp. 991–999.

Highlighted Publications appear more than once in the IIASA Publications List:

Green entries: IIASA author researches for more than one IIASA program, identified in brackets

Blue entries: IIASA author collaborated with IIASA colleague from different IIASA program, identified in brackets

Fath BD, Kryazhimskiy AV, Liljenstroem H, Rovenskaya E (2008). Introduction: towards the design of an integrated socioenvironmental assessment model for the Baltic Sea region. In: Neittaanmaki,J. Piriaux,T & Tuovinen P (eds), *Evolutionary Methods for Design, Optimization and Control*, CIMNE, Barcelona, Spain, pp. 425–429.

Krasovskii A, Kryazhimskiy A, Tarasyev A (2008) Optimal control design in models of economic growth. In: Neittaanmaki,J. Piriaux,T & Tuovinen P (eds), *Evolutionary Methods for Design, Optimization and Control*, CIMNE, Barcelona, Spain, pp. 70–75

Kryazhimskiy AV, Maksimov VI, Rovenskaya E, Rodkin MV (2008) On a regime of repetition of strong low-frequency events (catastrophes): new approaches and results of their applications. In: Change in the Environment and Climate. *Natural Catastrophes and Induced Technogenic Catastrophes*, Institute of Geography, Russian Academy of Sciences, Moscow 158–189 (in Russian)

Sibayev SV, Tarasyev MV, Decentralized searching of market equilibrium. In: Neittaanmaki,J. Piriaux,T & Tuovinen P (eds), *Evolutionary Methods for Design, Optimization and Control*, CIMNE, Barcelona, Spain, pp. 445–450

Journal Articles (Non-Peer-Reviewed)

Krasovskii AA & Tarasyev AM (2008). Optimization of the stopping time in multilevel dynamic systems. *Vestnik of the Udmurt University,* 2:64–65 [in Russian].

Other Publications (Non-Peer-Reviewed)

Casti J (2008). Turn out the lights, the party's over. Options; IIASA, Laxenburg, Austria, pp. 8–9.

Interim Reports (Non-Peer-Reviewed)

Brykalov SA, Nikonov OI & Melentsova MA (2008). Competition among Several Gas Pipelines: A Game Model with Exponential Functions. IIASA Interim Report IR-08-051.

Krasovskii AA, Tarasyev AM & Watanabe C (2008). Assessment of the Market Development Trajectory for Optimal Timing of Technological Innovation. IIASA Interim Report IR-08-007. (GEN)

Maksimov VI, Rozenberg VL, Kadiyev AM (2008). Some Results of Mathematical Modeling of the International Market for Emissions Permits. IIASA Interim Report IR-08-047.

Ortiz-Moctezuma MB, Pivovarchuk D, Szolgayova J & Fuss S (2008). Development of Transportation Infrastructure in the Context of Economic Growth. IIASA Interim Report IR-08-045. (FOR)

Palokangas T (2008). Economic Integration, Lobbying by Firms and Workers, and Technological Change. IIASA Interim Report IR-08-016.

Pivovarchuk D (2008). Consistency Between Long-term Climate Target and Short-term Abatement Policy. Attainability Analysis Technique. IIASA Interim Report IR-08-017. (APD, GGI)

Evolution and Ecology (EEP)

Journal Articles (Peer-Reviewed)

Baulier L & Heino M (2008). Norwegian spring-spawning herring as the test case of piecewise linear regression method for detecting maturation from growth patterns. *Journal of Fish Biology*, 73(10):2452–2467.

Christensen P, Ecke F, Sandstroem P, Nilsson M & Hoernfeldt B (2008). Can landscape properties predict occurrence of grey-sided voles. *Population Ecology*, 50(2):169–179

Colombo A, Dercole F & Rinaldi S (2008). Remarks on metacommunity synchronization with application to prey-predator systems. *American Naturalist*, 171(4):430–442.

Colombo A & Rinaldi S (2008). Chaos in two-party democracies. *International Journal of Bifurcation and Chaos*, 18(7):2133–2140.

Dercole F, Dieckmann U, Obersteiner M & Rinaldi S (2008). Adaptive dynamics and technological change. Technovation, 28(6):335–348. (FOR)

Durinx M, Metz JAJ & Meszena G (2008). Adaptive dynamics for physiologically structured population models. *Journal of Mathematical Biology*, 56(5):673–742.

Hard J, Gross MR, HeinoM, Hilborn R, Kope RG, Law R & Reynolds JD (2008). Evolutionary consequences of fishing and their implications for salmon. *Evolutionary Applications*, 1(2):388–408.

Hauert C, Traulsen A, De Silva-Brandt H, Nowak MA & Sigmund K (2008). Public goods with punishment and abstaining in finite and infinite populations. *Biological Theory*, 3(2):114–122.

Heino M, Baulier L, Boukal DS, Dunlop ES, Eliassen S, Enberg K, Joergensen C & Varpe O (2008). Evolution of growth in Gulf of St Lawrence cod. *Proceedings of the Royal Society B*, 275(1639):1111–1112.

Heino M & Dieckmann U (2008). Detecting fisheries-induced life-history evolution: An overview of the reaction-norm approach. *Bulletin of Marine Science*, 83(1):69–93.

Heino M, Engelhard GH & Godoe OR (2008). Migrations and hydrography determine the abundance fluctuations of blue whiting (*Micromesistius poutassou*) in the Barents Sea. *Fisheries Oceanography*, 17(2):153–163.

Heino M, Parvinen K & Dieckmann U (2008). Evolution of foraging strategies on resource gradients. *Evolutionary Ecology Research*, 10(8):1131–1156.

Kumar P, Hiremath US, Yelamaggad CV, Rossberg AG & Krishnamurthy KS (2008). Drifting periodic structures in a degenerate-planar bent-rod nematic liquid crystal beyond the dielectric inversion frequency. *Journal of Physical Chemistry B*, 112(31):9270–9274.

Kumar P, Hiremath US, Yelamaggad CV, Rossberg AG & Krishnamurthy KS (2008). Electroconvection in a homeotropic bent-rod nematic liquid crystal beyond the dielectric inversion frequency. *Journal of Physical Chemistry B*, 112(32):9753–9760.

Leimar O, Doebeli M & Dieckmann U (2008). Evolution of phenotypic clusters through competition and local adaptation along an environmental gradient. *Evolution*, 62(4):807–822.

Ludwig A, Arndt U, Lippold S, Benecke N, Debus L, King TL & Matsumura S (2008). Tracing the first steps of American sturgeon pioneers in Europe. *BMC Evolutionary Biology*, 8(1):221.

Matsumura S & Forster P (2008). Generation time and effective population size in Polar Eskimos. *Proceedings of the Royal Society B*, 275(1642):1501–1508.

Metz JAJ, Mylius SD & Diekmann O (2008). Even in the odd cases when evolution optimizes, unrelated population dynamical details may shine through in the ESS. *Evolutionary Ecology Research*, 10(5):655–666.

Metz JAJ, Mylius SD & Dieckmann O (2008). When does evolution optimize. *Evolutionary Ecology Research*, 10(5):629–654.

Nilsson J, Oestergren J, Lundqvist H & Carlsson U (2008). Genetic assessment of Atlantic salmon Salmo salar and sea trout *Salmo trutta* stocking in a Baltic Sea river. *Fish Biology*, 73(5):1201–1215.

Oestergren J & Rivinoja P (2008). Overwintering and downstream migration of sea trout (Salmo trutta L.) kelts under regulated flows – northern Sweden. *River Research and Applications*, 24(5):551–563.

Parvinen K & Metz JAJ (2008). A novel fitness proxy in structured locally finite metapopulations with diploid genetics, with an application to dispersal evolution. *Theoretical Population Biology*, 73(4):517–528.

Pennings PS, Kopp M, Meszena G, Dieckmann U & Hermisson J (2008). An analytically tractable model for competitive speciation. *The American Naturalist*, 171(1):E44–E71.

Peyrard N, Dieckmann U & Franc A (2008). Long-range correlations improve understanding of the influence of network structure on contact dynamics. *Theoretical Population Biology*, 73(3):383–394.

Rossberg AG (2008). Laplace transforms of probability distributions and their inversions are easy on logarithmic scales. *Journal of Applied Probability*, 45(2):531–541.

Rossberg AG (2008). Part-whole relations between food webs and the validity of local food-web descriptions. *Ecological Complexity*, 5(2):121–131.

Rossberg AG, Ishii R, Amemiya T & Itoh K (2008). The top-down mechanism for body-mass-abundance scaling. *Ecology*, 89(2):567–580.

Rossberg AG, Yoshida K & Ishii R (2008). Introduction: Current food-web theory. *Ecological Complexity*, 5(2):71–72.
Senechal M, Beham B & Sigmund K (2008). A short tale of two cities: Otto Schreier and the Hamburg–Vienna connection. *The Mathematical Intelligencer*, 30(3):27–35.
Serizawa H, Amemiya T, Enomoto T, Rossberg AG & Itoh K (2008). Mathematical modeling of colony formation in algal blooms: Phenotypic plasticity in cyanobacteria. *Ecological Research*, 23(5):841–850.
Serizawa H, Amemiya T, Rossberg AG & Itoh K (2008). Computer simulations of seasonal outbreak and diurnal vertical migration of cyanobacteria. *Limnology*, 9(3):185–194.
Sutton TT, Porteiro FM, Heino M, Byrkjedal I, Langhelle G, Anderson CIH, Horne J, Soeiland H, Falkenhaug T, Godoe OR & Bergstad OA (2008). Vertical structure, biomass and topographic association of deep-pelagic fishes in relation to a mid-ocean ridge system. *Deep Sea Research Part II: Topical Studies in Oceanography*, 55(1–2):161–184.
Theriault V, Dunlop ES, Dieckmann U, Bernatchez L & Dodson JJ (2008). The impact of fishing-induced mortality on the evolution of alternative life-history tactics in brook charr. *Evolutionary Applications*, 1(2):409–423.
Troost TA, Kooi BW & Dieckmann U (2008). Joint evolution of predator body size and prey-size preference. *Evolutionary Ecology*, 22(6):771–799.
Urbach D, Britschgi A, Jacob A, Bittner D, Bernet D, Wahli T, Yoccoz NG & Wedekind C (2008). Gonadal alterations in male whitefish Coregonus fatioi: No evidence for genetic damage reducing viability in early life stages. *Diseases of Aquatic Organisms*, 81(2):119–125.
Urbach D & Cotton S (2008). Comment: On the consequences of sexual selection for fisheries-induced evolution. *Evolutionary Applications*, 1(4):645–649.
Vaz S, Martin CS, Eastwood PD, Ernande B, Carpentier A, Meaden GJ & Coppin F (2008). Modelling species distributions using regression quantiles. *Journal of Applied Ecology*, 45(1):204–217.

Book Chapters (Peer-Reviewed)

Heino M & Dieckmann U (2008). Evolution and sustainability of harvested populations. In: Carroll SP & Fox CW (eds), *Conservation Biology: Evolution in Action*. Oxford University Press, Oxford, pp. 308–323.

Books (Peer-Reviewed)

Dercole F & Rinaldi S (2008). *Analysis of Evolutionary Processes: The Adaptive Dynamics Approach and Its Applications*. Princeton University Press, New Jersey, USA.

Other Publications (Non-Peer-Reviewed)

Joergensen C, Enberg K, Dunlop ES, Arlinghaus R, Boukal DS, Brander K, Ernande B, Gardmark A, Johnston F, Matsumura S, Pardoe H, Raab K, Silva A, Vainikka A, Dieckmann U, Heino M & Rijnsdorp AD (2008). The Role of Fisheries-induced Evolution – Response. Science; 320(5872):47–50.

Interim Reports (Non-Peer-Reviewed)

Fischer B, Taborsky B & Dieckmann U (2008). Unexpected Patterns of Plastic Energy Allocation in Stochastic Environments. IIASA Interim Report IR-08-035.

Energy (ENE)

Journal Articles (Peer-Reviewed)

Martinsen D & Krey V (2008). Compromises in energy policy – Using fuzzy optimization in an energy systems model. *Energy Policy*, 36(8):2983–2994.
O'Neill BC & Nakicenovic N (2008). Learning from global emissions scenarios. *Environmental Research Letters – Special Issue*, 3:045014. (PCC)
Pachauri S & Jiang L (2008). The household energy transition in India and China. *Energy Policy*, 36(11):4022–4035. (PCC, GGI)
Rogner H-H, McDonald A & Riahi K (2008). Long-term performance targets for nuclear energy. Part 1: The global scenario context. *International Journal of Global Energy Issues*, 30(1–4):28–76. (TNT)
Rogner H-H, McDonald A & Riahi K (2008). Long-term performance targets for nuclear energy. Part 2: Markets and learning rates. *International Journal of Global Energy Issues*, 30(1–4):77–101. (TNT)
van Vuuren DP, Meinshausen M, Plattner G-K, Joos F, Riahi K, de la Chesnaye F, den Elzen MGJ, Fujino J, Jiang K, Nakicenovic N, Paltsev S, Reilly J, et al. (2008). Temperature increase of 21st century mitigation scenarios. *Proceedings of the National Academy of Sciences of the United States of America*, 105(40):15258–15262. (TNT)
van Vuuren DP & Riahi K (2008). Do recent emission trends imply higher emissions forever? *Climatic Change*, 1–12. (TNT)

Books (Peer-Reviewed)

Aguilera RF (2008). *The Availability of Global Fossil Energy: How Long Will It Last?* VDM Verlag, Saarbruecken, Germany.
Bernstein L, Bosch P, Canziani O, Chen Z, Christ R & Riahi K et al. (Core Writing Team) (2008). *IPCC, 2007: Climate Change 2007: Synthesis Report*. IPCC, Geneva, Switzerland. (TNT)
Chambers A & Nakicenovic N (Contributors) (2008). *World Energy Outlook 2008*. IEA/OECD, Paris, France. (TNT)
Moss RH, Nakicenovic N & O'Neill BC (et al.) (2008). *Towards New Scenarios for Analysis of Emissions, Climate Change, Impacts, and Response Strategies*. IPCC, Geneva, Switzerland. (PCC)

Other Publications (Non-Peer-Reviewed)

IIASA/ENE/GEA (2008). Highlights from Preliminary Work on GEA. GEA Newsletter, Issue No. 4, IIASA, Laxenburg, Austria.
IIASA/ENE/GEA (2008). Recently Appointed CLA's. GEA Newsletter, Issue No.3, IIASA, Laxenburg, Austria.
Nussbaumer P (2008). Making energy poverty history in Africa. Options; IIASA, Laxenburg, Austria, pp. 18–19.

Interim Reports (Non-Peer-Reviewed)

Ma T, Gruebler A, Nakicenovic N & Arthur WB (2008). Technologies as Agents of Change: A Simulation Model of the Evolving Complexity of the Global Energy System. IIASA Interim Report IR-08-021. (TNT)
Pachauri S & Jiang L (2008). The Household Energy Transition in India and China. IIASA Interim Report IR-08-009. (PCC)
Rao S, Riahi K, Stehfest E, van Vuuren DP, Cho C, den Elzen MGJ, Isaac M & van Vliet J (2008). IMAGE and MESSAGE Scenarios Limiting GHG Concentration to Low Levels. IIASA Interim Report IR-08-020. (TNT)

Forestry (FOR)

Journal Articles (Peer-Reviewed)

Bottcher H, Freibauer A, Obersteiner M & Schulze E-D (2008). Uncertainty analysis of climate change mitigation options in the forestry sector using a generic carbon budget model. *Ecological Modelling*, 213(10):45–62.
Bottcher H, Kurz WA & Freibauer A (2008). Accounting of forest carbon sinks and sources under a future climate protocol-factoring out past disturbance and management effects on age-class structure. *Environmental Science & Policy*, 11(8):669–686.
Crespo Cuaresma J, Hlouskova J & Obersteiner M (2008). Natural disasters as creative destruction? Evidence from developing countries. *Economic Inquiry*, 46(2):214–226. (POP)
Dercole F, Dieckmann U, Obersteiner M & Rinaldi S (2008). Adaptive dynamics and technological change. *Technovation*, 28(6):335–348. (EEP)
Ecke H & Svensson M (2008). Mobility of organic carbon from incineration residues. *Waste Management*, 28(8):1301–1309.

Ermoliev Y, Ermolieva T, Fischer G, Makowski M, Nilsson S & Obersteiner M (2008). Discounting, catastrophic risks management and vulnerability modeling. *Mathematics and Computers in Simulation*, 79(4):917–924. (LUC)

Fortin I, Fuss S, Hlouskova J, Khabarov N, Obersteiner M & Szolgayova J (2008). An integrated CVaR and real options approach to investments in the energy sector. *The Journal of Energy Markets*, 1(2):61–85.

Fritz S, Massart M, Savin IY, Gallego J & Rembold F (2008). The use of MODIS data to derive acreage estimations for larger fields: A case study in the south-western Rostov region of Russia. *International Journal of Applied Earth Observation and Geoinformation*, 10(4):453–466.

Fritz S, Scholes RJ, Obersteiner M, Bouma J & Reyers B (2008). A conceptual framework for assessing the benefits of a Global Earth Observation System of Systems. *Systems Journal, IEEE*, 2(3):338–348.

Fritz S & See LM (2008). Identifying and quantifying uncertainty and spatial disagreement in the comparison of Global Land Cover for different applications. *Global Change Biology*, 14:1057–1075.

Fuss S, Szolgayova J & Obersteiner M (2008). A real options approach to satellite mission planning. *Space Policy*, 24(4):199–207.

Fuss S, Szolgayova J, Obersteiner M & Gusti M (2008). Investment under market and climate policy uncertainty. *Applied Energy*, 85(8):708–721. (GGI)

Khabarov N, Moltchanova E & Obersteiner M (2008). Valuing weather observation systems for forest fire management. *Systems Journal, IEEE*, 2(3):349–357.

Kindermann G, Obersteiner M, Sohngen B, Sathaye J, Andrasko K, Rametsteiner E, Schlamadinger B, Wunder S & Beach R (2008). Global cost estimates of reducing carbon emissions through avoided deforestation. *Proceedings of the National Academy of Sciences of the USA*, 105(30):10302–10307.

Kryazhimskiy AV, Obersteiner M & Smirnov A (2008). Infinite-horizon dynamic programming and application to management of economies effected by random natural hazards. *Applied Mathematics and Computation*, 204(2):609–620. (DYN)

Leduc S, Schwab D, Dotzauer E, Schmid E & Obersteiner M (2008). Optimal location of wood gasification plants for methanol production with heat recovery. *International Journal of Energy Research*, 32:1080–1091.

Liu J, Fritz S, van Wesenbeeck CFA, Fuchs M, You L, Obersteiner M & Yang H (2008). A spatially explicit assessment of current and future hotspots of hunger in Sub-Saharan Africa in the context of global change. *Global and Planetary Change*, 64(3–4):222–235.

Lundmark R (2008). Empirical specification of cost reductions associated with accumulated knowledge in the Swedish kraft paper industry. *Forest Policy and Economics*, 10(7–8):460–466.

Marland G & Obersteiner M (2008). Large-scale biomass for energy, with considerations and cautions: An editorial comment. *Climatic Change*, 87(3–4):335–342. (GGI)

Nilsson S (ed.) (2008). The Indian Forest Sector: Current Trends and Future Challenges. *International Forestry Review – Special Issue*, 10(2):101–421.

Nilsson S (2008). The Indian forestry system at a crossroads: An outsider's view. *International Forestry Review*, 10(2):414–421.

Nilsson S (2008). Introduction: The Indian Forest Sector: Current Trends and Future Challenges. *International Forestry Review*, 10(2):101.

Pekka L, Halmeenpaeae H, Ecke F, Vuori K-M, Mokrotovarova O, Ingri J & Oehlander B (2008). Assessing pollution in the Kola River, northwestern Russia, using metal concentrations in water and bryophytes. *Boreal Environment Research*, 13(1):15–30.

Shvidenko AZ, Shchepashchenko DG, Nilsson S & Vaganov EA (2008). Net primary production of forest ecosystems of Russia: A new estimate. *Doklady Earth Sciences*, 421A(6):1009–1012.

Smirnov A (2008). Necessary optimality conditions for a class of optimal control problems with discontinuous integrand. *Proceedings of the Steklov Institute of Mathematics*, 262(1):213–230.

Szolgayova J, Fuss S & Obersteiner M (2008). Assessing the effects of CO_2 price caps on electricity investments – A real options analysis. *Energy Policy*, 36(10):3974–3981.

Book Chapters (Peer-Reviewed)

Fritz S, See LM, Rembold F, Massart M, Negre T & von Hagen C (2008). Comparing different land cover data sets for agricultural monitoring in Africa. In: Mount N, Aplin P, Priestnall G & Harvey & G (eds), *Representing, Modeling and Visualizing the Natural Environment*. Routledge, London, UK, pp. 67–85.

Fuss S, Khabarov N, Szolgayova J & Obersteiner M (2008). The effects of climate policy on the energy technology mix: An integrated CVaR and Real Options Approach. In: Golub A & Markandya A (eds), *Modeling Environment-Improving Technological Innovations under Uncertainty*. Routledge, London, UK.

Shvidenko A (2008). Deforestation and desertification. In: Jorgenssen SE & Fath BD (eds), *Encyclopedia of Ecology*. Elsevier, Amsterdam, The Netherlands, pp. 853–859.

van Zon A & Fuss S (2008). Risk, embodied technical change and irreversible investment decisions in UK electricity production: An optimum technology portfolio approach. In: Bazilian M & Roques F (eds), *Analytical Methods for Energy Diversity and Security*. Elsevier BV, Amsterdam, Netherlands.

Books (Peer-Reviewed)

Bottcher H (2008). *Forest Management for Climate Change Mitigation. Modeling of Forestry Options, their Impact on the Regional Carbon Balance and Implications for a Future Climate Protocol*. VDM Verlag, Saarbruecken, Germany.

Journal Articles (Non-Peer-Reviewed)

Bun A & Jonas M (2008). Information system for verification of compliance with greenhouse gas emission commitments: Ukraine and the European Union member states. *Visnik of the Volodymyr Dal East Ukrainian National University*, 119(1): 25–31.

Cao G-Y (2008). The risk of natural disaster and social insurance of rural population: Lessons and challenges for China. *Population and Development*, 14(4):22–27.

Fischer G, Cao G-Y, Ermolieva T & Sun L (2008). Urbanization and livestock production projection: An approach to healthy and environmental risks. *Population and Development*, 6(2):1674–1668. (LUC)

Gusti M & Jonas M (2008). How well do we know Russia's carbon budget for 1988–1992 Critical look from uncertainty study of IIASA's full carbon account. *Geophysical Research Abstracts*, 10:EGU2008-A-09464.

Kindermann G, McCallum I, Fritz S & Obersteiner M (2008). A global forest growing stock, biomass and carbon map based on FAO statistics. *Silva Fennica*, 42(3):387–396.

Shvidenko A (2008). About normal stands, truth and scientific ethics. *Forest Inventory and Planning*, 1(39):6–9.

Shvidenko A, Shchepashchenko DG & Nilsson S (2008). Current increment of forests of Russia: An estimate at beginning of the 3rd Millennium. *Forest Inventory and Planning*, 1(39):83–100.

Book Chapters (Non-Peer-Reviewed)

Ermoliev Y, Ermolieva T, Jonas M, Makowski M & Fischer G (2008). Emission trading under uncertainties. In: *Statistics in Ukraine: Current Situation, Problems and Trends*. State Statistics Committee of Ukraine, Kiev, Ukraine, pp. 9–15. (LUC)

Kraxner F, Owari T & Mater C (2008). Green building drives construction market and forest certification: Certified forest products markets, 2007–2008. In: *Forest Products Annual Market Review*.

Other Publications (Non-Peer-Reviewed)

Bottcher H, Aoki K, De Cara S, Gusti M, Havlik P, Kindermann G, Schneider UA & Obersteiner M (2008). GHG Mitigation Potentials and Costs from Land-Use, Land-Use Change and Forestry (LULUCF) in Annex 1 Countries. GAINS Methodology Report; IIASA, Laxenburg, Austria, 39 pp.

Cao G-Y (co-author) (2008). The Report on the Tenth Session of Committee for Development Policy, 2008. Official Records, E/2008/33, Supplement No. 13; Economic and Social Council, United Nations, New York, USA.

Gusti M, Havlik P & Obersteiner M (2008). Technical Description of the IIASA Model Cluster. The Eliasch Review; Office of Climate Change, UK.
Jonas M, Gusti M & Nilsson S (2008). Assessing Uncertainty in Bottom-up Full Carbon Accounting for Russia. Brief project report. IIASA, Laxenburg, Austria.
Nilsson S (2008). Globalization and Africa's forests. Options; IIASA, Laxenburg, Austria, pp. 26–27.
Rametsteiner E (2008). Governance for Sustainable Forest Management at Local and Regional Levels. In: *United Nations Forum on Forests. Enabling Sustainable Forest Management: Strategies for equitable development, for forests, for people*; United Nations, New York, USA.
Rametsteiner E (2008). Governing Forest-based Economic Development on Local and Regional Levels. In:; United Nations Forum on Forests. Enabling Sustainable Forest Management: Strategies for equitable development, for forests, for people; United Nations, New York, USA.
Roberts D, White A & Nilsson S (2008). Convergence of Food, Fuel and Fibre Markets: Driving Change in the World's Forests. In: Arbor Vitae: Issue #37, p. 8.
Roberts D, White A & Nilsson S (2008). Forests and Biofuel Production. Canadian Silviculture; November 2008.
Shvidenko A (2008). A forest tale of two Koreas. Options; IIASA, Laxenburg, Austria, pp. 16–17.
Shvidenko A, Shchepashchenko DG, Nilsson S & Buluy YI (2008). Tables and Models of Growth and Productivity of Forests of Major Forest Forming Species of Northern Eurasia (Standard and Reference Materials). Federal Agency of Forest Management; Moscow, Russia [in Russian and English].
Szolgayova J, Fuss S & Obersteiner M (2008). Investing in Power Plants: Effects of Volatile CO_2 Prices and Price Caps. Science for Environment Policy.
Willmore L (2008). Book Review: Intergenerational Support and Old Age in Africa. Isabela Aboderin (ed). Population and Development Review; 34(3):572–574.
Willmore L & Kidd S (2008). Tackling Poverty in Old Age: A Universal Pension for Sri Lanka. HelpAge International; London, United Kingdom.

Conference Proceedings (Non-Peer-Reviewed)

Comber A, Carver S, Fritz S, McMoran R & Washtell J (2008). Mapping uncertainty in perceptions of landscape `wildness'. In: *Proceedings, GISRUK 2008*. GISRUK Conference, 2–4 April 2008, Manchester, UK.
Ermoliev Y, Ermolieva T, Jonas M, Makowski M & Fischer G (2008). Robust emission trading schemes under uncertainties. In: *Proceedings, International Workshop on Problems of Decision Making Under Uncertainties*. 22–27 September 2008, Novy Svit, Ukraine, pp. 16–22. (LUC)
Gusti M, Jonas M, Shvidenko A & McCallum I (2008). How well do we know Russia's carbon budget for 1988–1992? Critical look from uncertainty study of IIASA's full carbon account. In: Di X, Wang C & Wang X (eds), *Program and Abstract Book*. The 14th Scientific Conference of the International Boreal Forest Research Association (IBFRA), 22–27 September, Harbin, China, p.152.
Kraxner F, Yang J & Yamagata Y (2008). Perceived barriers to an increased forest use for bioenergy by the public and forest owners in rural Japan. In: *Proceedings, International Conference of Renewable Energy 2008 (RE2008)*. 13–17 October 2008, Busan, Korea
Pulzl H & Rametsteiner E (2008). Indicator development as "boundary spanning" between scientists and policy makers. In: *Proceedings of the Human Dimensions Programme on Global Environmental Change (IHDP) Conference*. 19–20 February 2008, Berlin, Germany
Rametsteiner E (2008). Governance concepts and their application in forest policy initiatives from international to local levels. In: *Proceedings of the IUFRO Conference, "Small-scale Rural Forest Use and Management: Global Policies vs. Local Knowledge"*. 22–26 June, Gerardmer, France.
Rametsteiner E, Pulzl H, Alkan-Olsson J & Frederiksen P (2008). Sustainability indicator development – science or political negotiation In: *Proceedings of the IALUC Conference*. 7–10 April 2008, Berlin, Germany.
Shvidenko A, Nilsson S, Shchepashchenko DG & McCallum I (2008). Productivity of northern Eurasian forests in a changing world. In: Di X, Wang C & Wang X (eds), *Program and Abstract Book*. The 14th Scientific Conference of the International Boreal Forest Research Association (IBFRA), 22–27 September, Harbin, China, pp. 33–34.
Shvidenko A, Shchepashchenko DG, McCallum I & Nilsson S (2008). Land cover of Russia: system integration of remote sensing and ground data. In: *Enviromis 2008. International Conference on Environmental Observations, Modeling and Information Systems*. 28 June–6 July 2008, Tomsk, Russia p.115.
Shvidenko A, Shchepashchenko DG & Nilsson S (2008). Materials to understanding productivity of Russian forests. In: *Proceedings of the International Workshop on Sustainable Management of Russian Forests*. 5 December 2007, Krasnoyarsk, Russia, pp. 1–31.
Shvidenko A, Shchepashchenko DG, Nilsson S & McCallum I (2008). Major indicators of productivity of Russian forests: a system reanalysis. In: *Enviromis 2008. International Conference on Environmental Observations, Modeling and Information Systems*. 28 June–6 July 2008, Tomsk, Russia, pp. 99–100.
Umeya C, Rametsteiner E & Kraxner F (2008). Quantifying impacts of governance on deforestation. In: *Tropical Forestry Change in a Changing World*. November 2008, Bangkok, Thailand.

Interim Reports (Non-Peer-Reviewed)

Bun A (2008). The Kyoto Policy Process in Perspective: Long-term Concentration Targets versus Short-term Emissions. IIASA Interim Report IR-08-034.
Hamal K & Jonas M (2008). Preparatory Signal Detection for the EU-25 Member States under EU Burden Sharing/Advanced Monitoring Including Uncertainty (1990–2004). IIASA Interim Report IR-08-036.
Hamal K & Jonas M (2008). Preparatory Signal Detection for the EU-27 Member States under EU Burden Sharing – Advanced Monitoring Including Uncertainty (1990–2005). IIASA Interim Report IR-08-037.
McCallum I, Kidd R, Fritz S, Kraxner F & Obersteiner M (2008). Banda Aceh-The Value of Earth Observation Data in Disaster Recovery and Reconstruction: A Case Study. IIASA Interim Report IR-08-048.
Ortiz-Moctezuma MB, Pivovarchuk D, Szolgayova J & Fuss S (2008). Development of Transportation Infrastructure in the Context of Economic Growth. IIASA Interim Report IR-08-045. (DYN)
Schoenhart M (2008). Profitability of Short Rotation Forestry in Austria. IIASA Interim Report IR-08-043.
Yengoh TY (2008). Explaining the Causes of Deforestation with the Hyde Model (A Conceptual Framework). IIASA Interim Report IR-08-039.

General Research (GEN)

Journal Articles (Peer-Reviewed)

Fukuda K & Watanabe C (2008). Japanese and US perspectives on the National Innovation Ecosystem. *Technology in Society*, 30(1):49–63. (DYN)
Watanabe C, Lei S (2008). The role of techno-countervailing power in inducing the development and dissemination of new functionality – An analysis of Canon printers and Japan's personal computers. *International Journal of Technology Management*, 44(1–2):205–233. (DYN)

Interim Reports (Non-Peer-Reviewed)

Krasovskii AA, Tarasyev AM & Watanabe C (2008). Assessment of the Market Development Trajectory for Optimal Timing of Technological Innovation. IIASA Interim Report IR-08-007. (DYN)

Greenhouse Gas Initiative (GGI)

Journal Articles (Peer-Reviewed)

Crutzen PJ, Mosier AR, Smith KA & Winiwarter W (2008). N_2O release from agro-biofuel production negates global warming reduction by replacing fossil fuels. *Atmospheric Chemistry and Physics*, 8(2):389–395. (APD)

Fuss S, Szolgayova J, Obersteiner M & Gusti M (2008). Investment under market and climate policy uncertainty. *Applied Energy*, 85(8):708–721. (FOR)

Gregg JS, Andres RJ & Marland G (2008). China: Emissions pattern of the world leader in CO_2 emissions from fossil fuel consumption and cement production. *Geophysical Research Letters*, 35(8):L0880.

Marland G (2008). Uncertainties in accounting for CO_2 from fossil fuels. *Journal of Industrial Ecology*, 12(2):136–139.

Marland G & Obersteiner M (2008). Large-scale biomass for energy, with considerations and cautions: An editorial comment. *Climatic Change*, 87(3–4):335–342.

O'Neill BC & Sanderson WC (2008). Population, uncertainty, and learning in climate change decision analysis. *Climate Change*, 89(1–2):87–123. (PCC, POP)

Pachauri S & Jiang L (2008). The household energy transition in India and China. *Energy Policy*, 36(11):4022–4035. (ENE)

Strassmann KM, Joos F & Fischer G (2008). Simulating effects of land use changes on carbon fluxes: Past contributions to atmospheric CO_2 increases and future commitments due to losses of terrestrial sink capacity. *Tellus, Series B: Chemical and Physical Meteorology*, 60(4):583–603. (LUC)

Book Chapters (Peer-Reviewed)

Hochrainer S & Mechler R (2008). Assessing financial and economic vulnerability to natural hazards: Bridging the gap between scientific assessment and the implementation of disaster risk management with the CatSim model. In: Patt A, Schroeter D, D, Klein RJT & de la Vega-Leinert AC (eds), *Assessing Vulnerability to Global Environmental Change*. Earthscan, London, UK, pp. 173–194. (RAV)

Patt A, Schroeter D, de la Vega-Leinert AC & Klein RJT (2008). An introduction to the diversity of approaches to vulnerability research and assessment: common features and lessons learned. In: Patt A, Schroeter D, Klein RJT & de la Vega-Leinert AC (eds), *Assessing Vulnerability to Global Environmental Change*. Earthscan, London, pp. 1–26. (RAV)

Books (Peer-Reviewed)

Patt A, Schroeter D, Klein RJT & de la Vega-Leinert AC (eds) (2008). *Assessing Vulnerability to Global Environmental Change. Making Research Useful for Adaptation Decision Making and Policy*. Earthscan, London, United Kingdom. (RAV)

Other Publications (Non-Peer-Reviewed)

Klimont Z & WiniwarterW (2008). 100 years of ammonia synthesis. Options; IIASA, Laxenburg, Austria p. 10. (APD)

Conference Proceedings (Non-Peer-Reviewed)

Pachauri S & Mueller A (2008). An analysis of electricity access and use in Indian households: A regional decomposition of consumption for 1980–2005. In: *Proceedings, 31st IAEE International Conference: Bridging Energy Supply and Demand: Logistics, Competition and Environment*. 18–20 June 2008, Istanbul Turkey. (PCC)

Interim Reports (Non-Peer-Reviewed)

Pachauri S & Jiang L (2008). The Household Energy Transition in India and China. IIASA Interim Report IR-08-009. (PCC)

Pivovarchuk D (2008). Consistency Between Long-term Climate Target and Short-term Abatement Policy. Attainability Analysis Technique. IIASA Interim Report IR-08-017. (DYN, APD)

Rao S, Riahi K, Stehfest E, van Vuuren DP, Cho C, den Elzen MGJ, Isaac M & van Vliet J (2008). IMAGE and MESSAGE Scenarios Limiting GHG Concentration to Low Levels. IIASA Interim Report IR-08-020. (ENE)

Health and Global Change (HGC)

Journal Articles (Peer-Reviewed)

Noymer A (2008). Influenza analysis should include pneumonia. *American Journal of Public Health*, 98(11):1927–1928.

Noymer A & Jarosz B (2008). Causes of death in nineteenth-century new England: The dominance of infectious disease. *Social History of Medicine*, 21(3):573–578.

Other Publications (Non-Peer-Reviewed)

MacKellar L & McGreevey W (2008). Analyzing health infrastructure Investment in Lesotho. Options; IIASA, Laxenburg, Austria, pp. 22–23.

Conference Proceedings (Non-Peer-Reviewed)

Hammer J, MacKellar L & Acharya A (2008). Propinquity matters: How better health, urbanization, and total factor productivity grew together. In: *IIASA/ICSU Symposium on Health, Urbanization and Development*. 24–25 January 2008, IIASA, Laxenburg, Austria.

Integrated Modeling Environment (IME)

Journal Articles (Peer-Reviewed)

Alberth S (2008). Forecasting technology costs via the experience curve – Myth or magic. *Technological Forecasting and Social Change*, 75(7):952–983.

Carrera-Hernandez JJ & Gaskin SJ (2008). The Basin of Mexico Hydrogeological Database (BMHDB): Implementation, queries and interaction with open source software. *Environmental Modelling & Software*, 23:1271–1279.

Carrera-Hernandez JJ & Gaskin SJ (2008). Spatio-temporal analysis of potential aquifer recharge: Application to the Basin of Mexico. *Journal of Hydrology*, 253:228–246.

Ermoliev Y, Ermolieva T, Fischer G, Makowski M, Nilsson S & Obersteiner M (2008). Discounting, catastrophic risks management and vulnerability modeling. *Mathematics and Computers in Simulation*, 79(4):917–924. (LUC, FOR)

Flam SD & Ermoliev Y (2008). Investment, uncertainty, and production games. *Environment and Development Economics*, 14:51–66.

Book Chapters (Peer-Reviewed)

Ermolieva T, Ermoliev Y, Fischer G & Makowski M (2008). Integrated modeling for management of catastrophic risks: Spatial stochastic optimization model. In: Knopov PS & Pardalos PM (eds), *Simulation and Optimization Methods in Risk and Reliability Theory*. Nova Science Publishers, New York, USA. (LUC)

Journal Articles (Non-Peer-Reviewed)

Yarovyy V, Fischer G & Ermolieva T (2008). Land pricing mechanisms for sustainable agricultural land use planning in Ukraine. *EUROPA XXI: New Functions of Rural and Industrial Space in Central and Eastern Europe*, 17:109–119. (LUC)

Book Chapters (Non-Peer-Reviewed)

Ermoliev Y, Ermolieva T, Jonas M, Makowski M & Fischer G (2008). Emission trading under uncertainties. In: *Statistics in Ukraine: Current Situation, Problems and Trends*. State Statistics Committee of Ukraine, Kiev, Ukraine, pp. 9–15. (FOR, LUC)

Fischer G & Ermolieva T (2008). Problems of decision making in agriculture under risks and uncertainties. In: *Statistics in Ukraine: Current Situation, Problems and Trends*. State Statistics Committee of Ukraine, Kiev, Ukraine. (LUC)

Other Publications (Non-Peer-Reviewed)

Ermoliev Y, Ermolieva TY & Makowski M (2008). Scientific bridge building under uncertainty. Options; IIASA, Laxenburg, Austria, pp. 22–23. (LUC)

Conference Proceedings (Non-Peer-Reviewed)

Ermoliev Y, Ermolieva T, Jonas M, Makowski M & Fischer G (2008). Robust emission trading schemes under uncertainties. In: *Proceedings, International Workshop: on Problems of Decision Making Under Uncertainties*. 22–27 September 2008, Novy Svit, Ukraine. p. 131. (LUC, FOR)

Fischer G & Ermolieva T (2008). Decisions making under risks and uncertainties in agriculture. In: *Proceedings, International Workshop on Problems of Decision Making under Uncertainties*. 22–27 September 2008, Novy Svit, Ukraine, pp. 21–23. (LUC)

Interim Reports (Non-Peer-Reviewed)

Kanata S (2008). Man-Machine Control of Space Robots under Uncertainty. IIASA Interim Report IR-08-023.

Kiczko A (2008). Multicriteria Decision Support System for Siemianowka Reservoir under Uncertainties. IIASA Interim Report IR-08-026.

Larson A (2008). A Framework for Evaluating Emergency Preparedness Plans and Response Strategies. IIASA Interim Report IR-08-008.

Zhang D (2008). Kernel-based Estimation Method. IIASA Interim Report IR-08-025.

Land Use Change and Agriculture (LUC)

Journal Articles (Peer-Reviewed)

Ermoliev Y, Ermolieva T, Fischer G, Makowski M, Nilsson S & Obersteiner M (2008). Discounting, catastrophic risks management and vulnerability modeling. *Mathematics and Computers in Simulation*, 79(4):917–924. (IME, FOR)

Ermolieva TY & Sergienko IV (2008). Catastrophe risk management for sustainable development of regions under risks of natural disasters. *Cybernetics and Systems Analysis*, 44(3):1–13.

Fischer G, Ermolieva T, Ermoliev Y & Sun L (2008). Risk-adjusted approaches for planning sustainable agricultural development. *Stochastic Environmental Research and Risk Assessment*, 1–10. (IME)

Keller K, Tol RSJ, Toth FL & Yohe GW (2008). Abrupt climate change near the poles. *Climatic Change*, 91(1–2):1–4.

Strassmann KM, Joos F & Fischer G (2008). Simulating effects of land use changes on carbon fluxes: Past contributions to atmospheric CO_2 increases and future commitments due to losses of terrestrial sink capacity. *Tellus, Series B: Chemical and Physical Meteorology*, 60(4):583–603. (GGI)

Tian Z, Shi J, Gao Z, Tubiello FN (2008). Assessing the impact of future climate change on wheat production in Huang-Huai-Hai Plain in China based on GIS and crop model. *Proceedings of SPIE – The International Society for Optical Engineering*, 7083:70830H.

Toth FL & Hizsnyik E (2008). Managing the inconceivable: Participatory assessments of impacts and responses to extreme climate change. *Climatic Change*, 91(1–21):81–101.

Book Chapters (Peer-Reviewed)

Ermolieva T, Ermoliev Y, Fischer G & Makowski M (2008). Integrated modeling for management of catastrophic risks: Spatial stochastic optimization model. In: Knopov PS & Pardalos PM (eds), *Simulation and Optimization Methods in Risk and Reliability Theory*. Nova Science Publishers, New York, USA. (IME)

Fischer G, Teixeira E, Tothne Hizsnyik E & van Velthuizen HT (2008). Land use dynamics and sugarcane production. In: Zuurbier P & van de Vooren J (eds), *Sugarcane Ethanol. Contributions to Climate Change and the Environment*. Wageningen Academic Publishers, Wageningen, The Netherlands, pp. 29–62.

Toth FL (2008). Dealing with surprises in environmental scenarios. In: Alcamo J (ed.), *Environmental Futures – The Practice of The Practice of Environmental Scenario Analysis (Developments in Integrated Environmental Assessment, Vol.2)*. Elsevier BV, Amsterdam, Netherlands, pp. 169–193.

Journal Articles (Non-Peer-Reviewed)

Fischer G, Cao G-Y, Ermolieva T & Sun L (2008). Urbanization and livestock production projection: An approach to health and environmental risks. *Population and Development*, 6 [in Chinese]. (FOR)

Yarovyy V, Fischer G & Ermolieva T (2008). Land pricing mechanisms for sustainable agricultural land use planning in Ukraine. *EUROPA XXI: New Functions of Rural and Industrial Space in Central and Eastern Europe*, 17:109–119.

Book Chapters (Non-Peer-Reviewed)

Ermoliev Y, Ermolieva T, Jonas M, Makowski M & Fischer G (2008). Emission trading under uncertainties. In: *Statistics in Ukraine: Current Situation, Problems and Trends*. State Statistics Committee of Ukraine, Kiev, Ukraine, pp. 9–15. (FOR, IME)

Fischer G & Ermolieva T (2008). Problems of decision making in agriculture under risks and uncertainties. In: *Statistics in Ukraine: Current Situation, Problems and Trends*. State Statistics Committee of Ukraine, Kiev, Ukraine.

Other Publications (Non-Peer-Reviewed)

Fischer G, Shah M & van Velthuizen H (2008). Climate change and agriculture in Africa. Options; IIASA, Laxenburg, Austria, pp. 16–17.

Conference Proceedings (Non-Peer-Reviewed)

Ermoliev Y, Ermolieva T, Jonas M, Makowski M & Fischer G (2008). Robust emission trading schemes under uncertainties. In: *Proceedings of International Workshop: Problems of Decision Making Under Uncertainties*. 22–27 September 2008, Novy Svit, Ukraine. p. 131. (FOR, IME)

Fischer G & Ermolieva T (2008). Decisions making under risks and uncertainties in agriculture. In: *Proceedings, International Workshop on Problems of Decision Making under Uncertainties*. 22–27 September 2008, Novy Svit, Ukraine, pp. 21–23. (IME)

Interim Reports (Non-Peer-Reviewed)

Chhetri NB (2008). Decision Making under Uncertainty: Ranking of Multiple Stressors on Central ArizonaWater Resources. IIASA Interim Report IR-08-029.

Chhetri NB (2008). Understanding the Process of Agricultural Adaptation to Climate Change: Analysis of Climate-Induced Innovation in Rice Based Cropping System of Nepal. IIASA Interim Report IR-08-028.

Processes of International Negotiation Network (PIN)

Journal Articles (Peer-Reviewed)

Faure GO (2008). Negotiating with terrorists: A discrete form of diplomacy. *The Hague Journal of Diplomacy*, 3(2):179–200.

Books (Peer-Reviewed)

Bercovitch J, Kremenyuk VA & Zartman IW (eds) (2008). *The SAGE Handbook of Conflict Resolution*. Sage Publications Ltd, London, United Kingdom.

Other Publications (Non-Peer-Reviewed)

Anstey M (2008). Transforming Africa's conflicts into nation-building projects. Options; IIASA, Laxenburg, Austria, pp. 20–21.

Macaspac Penetrante A (2008). Bridge building in the Caspian Sea. Options; IIASA, Laxenburg, Austria, pp. 8–9.

Population and Climate Change (PCC)

Journal Articles (Peer-Reviewed)

Dalton MG, O'Neill BC, Prskawetz A, Jiang L & Pitkin J (2008). Population aging and future carbon emissions in the United States. *Energy Economics*, 30(2):642–675.

Luken R, Van Rompaey F & Zigova K (2008). The determinants of EST adoption by manufacturing plants in developing countries. *Ecological Economics*, 66(1):141–152.

O'Neill BC (2008). Learning and climate change: An introduction and overview. *Climatic Change*, 89(1–2):1–6.

O'Neill BC & Melnikov NB (2008). Learning about parameter and structural uncertainty in carbon cycle models. *Climatic Change*, 89(1–2):23–44.
O'Neill BC, Pulver S, Van Deveer S & Garb Y (2008). Where next with global environmental scenarios *Environmental Research Letters*, 3:045012(4pp).
O'Neill BC & Sanderson WC (2008). Population, uncertainty, and learning in climate change decision analysis. *Climate Change*, 89(1–2):87–123. (POP)
Oppenheimer M, O'Neill BC & Webster M (2008). Negative learning. *Climatic Change*, 89(1–2):155–172.
Pachauri S & Jiang L (2008). The household energy transition in India and China. *Energy Policy*, 36(11):4022–4035. (GGI, ENE)

Books (Peer-Reviewed)

Moss RH, Nakicenovic N & O'Neill BC (et al.) (2008). *Towards New Scenarios for Analysis of Emissions, Climate Change, Impacts, and Response Strategies*. IPCC, Geneva, Switzerland. (ENE)

Journal Articles (Non-Peer-Reviewed)

Oppenheimer M, O'Neill BC, Webster M & Agrawala S (2008). *Response. Science*, 319(5862):410.

Conference Proceedings (Non-Peer-Reviewed)

Dalton MG, O'Neill BC & Zigova K (2008). Effects of household age and size on the elasticity of energy consumption. In: *Proceedings, 31st IAEE International Conference. Bridging Energy Supply and Demand: Logistics, Competition and Environment*. 18–20 June 2008, Istanbul, Turkey.

Interim Reports (Non-Peer-Reviewed)

Pachauri S & Jiang L (2008). The Household Energy Transition in India and China. IIASA Interim Report IR-08-009. (ENE)
Tanaka K, Raddatz T, O'Neill BC & Reick CH (2008). Is the Climate Sensitivity Even More Uncertain IIASA Interim Report IR-08-012.

World Population (POP)

Journal Articles (Peer-Reviewed)

Azomahou T & Mishra T (2008). Age dynamics and economic growth: Revisiting the nexus in a nonparametric setting. *Economics Letters*, 99:67–71.
Crespo Cuaresma J, Hlouskova J & Obersteiner M (2008). Natural disasters as creative destruction Evidence from developing countries. *Economic Inquiry*, 46(2):214–226. (FOR)
Goujon A & KC Samir (2008). The past and future of human capital in South-east Asia. *Asian Population Studies*, 4(1):31–56.
Heiland F, Prskawetz A & Sanderson WC (2008). Are individuals' desired family sizes stable. Evidence from West German panel data. *European Journal of Population*, 24(2):129–156.
Khan HTA & Lutz W (2008). How well did past UN population projections anticipate demographic trends in six South-east Asian countries. *Asian Population Studies*, 4(1):77–95.
Kold Jensen T, Sobotka T, Hansen MA, Tonnes Pedersen A, Lutz W & Skakkebaek NE (2008). Declining trends in conception rates in recent birth cohorts of native Danish women: a possible role of deteriorating male reproductive health. *International Journal of Andrology*, 31(2):81–89.
Lutz W (2008). Europe's changing population in a global context. *European View*, 7(2):237–245.
Lutz W (2008). Has Korea's fertility reached the bottom The hypothesis of a "Low Fertility Trap" in parts of Europe and East Asia. *Asian Population Studies*, 4(1):1–4.
Lutz W, Crespo Cuaresma J & SandersonWC (2008). Economics: The demography of educational attainment and economic growth. *Science*, 319:1047–1048.
Lutz W, Sanderson WC & Scherbov S (2008). The coming acceleration of global population ageing. *Nature*, 451, 716–719.
Mishra T (2008). Stochastic demographic dynamics and economic growth. *Historical Social Research*, 33(4):9–190.
Mishra T, Adusei J & Parhi M (2008). Age-structured human capital and spatial total factor productivity dynamics. *Vienna Institute for Advance Studies Economics Series*, 226:1–33.
Mishra T & Diebolt C (2008). Demographic volatility and economic growth: convention and beyond. *Quality & Quantity*, 1–21.
Mishra T, Parhi M & Diebolt C (2008). Human capital accumulation and spatial TFP interdependence. *Historical Social Research*, 33(3):346–358.
O'Neill BC & Sanderson WC (2008). Population, uncertainty, and learning in climate change decision analysis. *Climate Change*, 89(1–2):87–123. (PCC)
Qiang R, Zheng X-Y, Lutz W & Scherbov S (2008). Uncertain demographic dynamics in China. *Chinese Journal of Population Science*, 6:19–27.
Sanderson WC & Scherbov S (2008). Rethinking age and aging. *Population Bulletin*, 63(4):1–16.
Skirbekk V (2008). Age and productivity capacity: Descriptions, causes and policy options. *Ageing Horizons*, 8:4–12.
Skirbekk V (2008). Fertility trends by social status. *Demographic Research*, 18(5):145–180.
Terama E, Ollila OHS, Salonen E, Rowat AC, Trandum C, Westh P, Patra M, Karttunen M & Vattulainen I (2008). Influence of ethanol on lipid membranes: From lateral pressure profiles to dynamics and partitioning. *Journal of Physical Chemistry B*, 112(13):4131–4139.

Book Chapters (Peer-Reviewed)

Bloom DE, Lutz W & Prskawetz A (2008). Introduction. In: Prskawetz A, Bloom DE, & Lutz W (eds), *Population Aging, Human Capital Accumulation, and Productivity Growth*. Population Council, New York, USA, pp. 3–14.
Lutz W (2008). Global population ageing and the world's future human capital. In: Healey P & Rayner S (eds), *Unnatural Selection. The Challenges of Engineering Tomorrow's People*. Earthscan, London, United Kingdom, pp. 221–228.
Lutz W, Goujon A & Wils AB (2008). The population dynamics of human capital accumulation. In: Prskawetz A, Bloom DE, & Lutz W (eds), *Population Aging, Human Capital Accumulation, and Productivity Growth*. Population Council, New York, USA, pp. 149–187.
Lutz W, Scherbov S (2008). Can immigration compensate for Europe's low fertility? In: *Hommage à Gerard Calot. Profession: Démographe*, P. Festy and J-P. Sardon (eds), Institut national d'études démographiques (INED), Paris, France, pp. 255–264.
Lutz W & Scherbov S (2008). O contributo da imigracao para o futuro demografico da Europa. In: Papademetriou DG (ed.), *A Europa e os Seus Imigrantes no Seculo XXI*. Fundacao Luso-Americana para o Desenvolvimento, Lisbon, Portugal, pp. 243–259. (In Portuguese)
Lutz W & Skirbekk V (2008). Low fertility in Europe in a global demographic context. In: Tremmel JC (ed.), *Demographic Change and Intergenerational Justice*. Springer Deutschland GmbH, Berlin, Germany, pp. 3–19.
Skirbekk V (2008). Age and productivity potential: A new approach based on ability levels and industry-wide task demand. In: Prskawetz A, Bloom DE, & Lutz W (eds), *Population Aging, Human Capital Accumulation, and Productivity Growth*. Population Council, New York, USA, pp. 191–207.

Other Publications (Peer-Reviewed)

Crespo Cuaresma J (2008). Okun's Law. In: S.N. Durlauf and L.E. Blume (eds); *The New Palgrave Dictionary of Economics*, 2nd edition; Basingstoke, United Kingdom.

Journal Articles (Non-Peer-Reviewed)

Lutz W (2008). On edellytys kesaevaelle kehitykselle. *Ulkopolitiikka*, 2/2008:13–16. (In Finnish)
Skirbekk V (2008). Age and productivity capacity: Descriptions, causes and policy options. *Over.Werk*, 1/2008:33–46.
Skirbekk V (2008). Ageing in the European regions. *Over.Werk*, 1/2008:71–72.

Books (Non-Peer-Reviewed)

Prskawetz A, Bloom DE & Lutz W (eds) (2008). *Population Aging, Human Capital Accumulation, and Productivity Growth*. Population Council, New York, USA.

Policy Reports (Non-Peer-Reviewed)

Lutz W (2008). Economic Growth in Developing Countries: Education Proves Key. IIASA Policy Brief #3.

Interim Reports (Non-Peer-Reviewed)

Abbasi-Shavazi MJ, Lutz W, Hosseini-Chavoshi M & KC Samir (2008). Education and the World's Most Rapid Fertility Decline in Iran. IIASA Interim Report IR-08-010.

Crespo Cuaresma J & Mishra T (2008). The Role of Age-Structured Data for Economic Growth Forecasts. IIASA Interim Report IR-08-003.

KC Samir, Barakat B, Goujon A, Skirbekk V & Lutz W (2008). Projection of Populations by Level of Educational Attainment, Age and Sex for 120 Countries for 2005–2050. IIASA Interim Report IR-08-038.

Lutz W, Sanderson WC & Scherbov S (2008). Global and Regional Population Ageing: How Certain Are We of its Dimensions IIASA Interim Report IR-08-015.

Lutz W & Scherbov S (2008). Exploratory Extension of IIASA's World Population Projections: Scenarios to 2300. IIASA Interim Report IR-08-022.

Riosmena F, Prommer I, Goujon A & KC Samir (2008). An Evaluation of the IIASA/VID Education-Specific Back Projections. IIASA Interim Report IR-08-019.

Scherbov S & Ediev D (2008). Probabilistic Household Projections based on an Extension of the Headship Rates Method with an Application to the Case of Russia. IIASA Interim Report IR-08-002.

Stonawski M (2008). Influence of Workforce Ageing on Human Capital Formation. IIASA Interim Report IR-08-005.

Risk and Vulnerability (RAV)

Journal Articles (Peer-Reviewed)

Amendola A, Linnerooth-Bayer J, Okada N & Shi P (eds) (2008). Towards integrated disaster risk management: Case studies and trends from Asia. *Natural Hazards*, 44(2):163–314.

Amendola A, Linnerooth-Bayer J, Okada N & Shi P (2008). Towards integrated disaster risk management: Case studies and trends from Asia. *Natural Hazards*, 44(2):163–168.

Kaemaeri J, Alcamo J, Baerlund I, Duel H, Farquharson F, Floerke M, Fry M, Houghton-Carr H, Kabat P, KaljonenM, Kok K, Meijer KS, Rekolainen S, Sendzimir J, Varjopuro R & Villars N (2008). Envisioning the future of water in Europe – the SCENES project. *E-WAter*, 2008/03.

Ostasiewicz K, Tyc MH, Radosz A, Magnuszewski P, Goliczewski P, Hetman P & Sendzimir J (2008). Multistability of impact, utility and threshold concepts of binary choice models. *Physica A: Statistical Mechanics and its Applications*, 387(25):6337–6352.

Pahl-Wostl C, Sendzimir J, Jeffrey P, Aerts J, Berkamp G & Cross K (2008). Managing change toward adaptive water management through social learning. *Ecology and Society*, 12(2):30.

Patt A & Schroeter D (2008). Perceptions of climate risk in Mozambique: Implications for the success of adaptation strategies. *Global Environmental Change*, 18(3):458–467. (GGI)

Suarez P, Ching F, Ziervogel G, Lamaire I, Turnquest D, de Suarez JM, Wisner B (2008). Video-mediated approaches for community-level climate adaptation. *IDS Bulletin*, 39(4):96–104.

Sendzimir J, Magnuszewski P, Flachner Z, Balogh P, Molnar G, Sarvari A & Nagy Z (2008). Assessing the resilience of a river management regime: Informal learning in a shadow network in the Tisza River Basin. *Ecology and Society*, 13(1):11.

Thompson M (2008). Clumsiness: Why isn't it as easy as falling off a log *Innovation*, 21(3):205–216.

Book Chapters (Peer-Reviewed)

Hochrainer S & Mechler R (2008). Assessing financial and economic vulnerability to natural hazards: Bridging the gap between scientific assessment and the implementation of disaster risk management with the CatSim model. In: Patt A, Schroeter D, D, Klein RJT & de la Vega-Leinert AC (eds), *Assessing Vulnerability to Global Environmental Change*. Earthscan, London, UK, pp. 173–194. (GGI)

Krolikowska K, Magnuszewski P, Magnuszewska J & Sendzimir J (2008). Dynamics of sustainable development – Karkonosze Mountains and Odra River Valley in Poland. In: Rohweder L & Virtanen A (eds), *Learning for a Sustainable Future. Innovative Solutions from the Baltic Sea Region*. The Baltic University Press, Uppsala, Sweden, pp. 112–122.

Patt A, Schroeter D, de la Vega-Leinert AC & Klein RJT (2008). An introduction to the diversity of approaches to vulnerability research and assessment: common features and lessons learned. In: Patt A, Schroeter D, Klein RJT & de la Vega-Leinert AC (eds), *Assessing Vulnerability to Global Environmental Change*. Earthscan, London, pp. 1–26. (GGI)

Sendzimir J (2008). Patterns of landscape structure, by discontinuity. In: Allen CR & Holling CS (eds), *Discontinuities in Ecosystems and Other Complex Systems*. Columbia University Press, New York, USA, pp. 61–82.

Stow C & Sendzimir J (2008). Evaluating the textural discontinuity hypothesis: A case for adaptive inference. In: Allen CR & Holling CS (eds), *Discontinuities in Ecosystems and Other Complex Systems*. Columbia University Press, New York, USA, pp. 165–178.

Books (Peer-Reviewed)

Patt A, Schroeter D, Klein RJT & de la Vega-Leinert AC (eds) (2008). *Assessing Vulnerability to Global Environmental Change. Making Research Useful for Adaptation Decision Making and Policy*. Earthscan, London, United Kingdom. (GGI)

Thompson M (2008). *Organising and Disorganising. A Dynamic and Non-Linear Theory of Institutional Emergence and Its Implication*. Triarchy Press, Devon, United Kingdom.

Policy Reports (Peer-Reviewed)

Aaheim A, Berkhout F, McEvoy D, Mechler R, Neufeldt H, Patt A, Watkiss P, Wreford A, Kundzewicz Z, Lavalle C & Egenhofer C (2008). Adaptation to Climate Change: Why is it needed and how can it be implemented? CEPS Policy Briefs; No. 161. (GGI)

Hochrainer S, Mechler R, Pflug GC & Lotsch A (2008). Investigating the Impact of Climate Change on the Robustness of Index-Based Microinsurance in Malawi. World Bank Policy Research Working Paper; No. 4631. (GGI)

Conference Proceedings (Peer-Reviewed)

Hochrainer S & Mechler R (2008). Assessing long-term socioeconomic adaptation strategies to extreme events in Europe. In: *Proceedings, Berlin Conference on the Human Dimensions of Global Environmental Change. Long-Term Policies: Governing Social-Ecological Change*. 22–23 February, 2008, Berlin, Germany. (GGI)

Other Publications (Non-Peer-Reviewed)

Khan F, Mustafa D & Kull D (2008). Evaluating the Costs and Benefits of Disaster Risk Reduction under Changing Climatic Conditions: A Pakistan Case Study. In: M. Moench, E. Caspari & A. Pokhrel (eds); *From Risk to Resilience* Working Paper No. 7; ISET, ISET-Nepal and ProVention, Kathmandu, Nepal, 24 pp.

Kull D, Chopde S & Singh P (2008). Evaluating Costs and Benefits of Disaster Risk Reduction under Changing Climatic Conditions: Case of the Rohini River Basin, India. In: M. Moench, E. Caspari and A. Pokhrel (eds); *From Risk to Resilience* Working Paper 4; ISET-Nepal and ProVention, Kathmandu, Nepal, 32 pp.

Lasut A, van Vliet M, Kok K & Sendzimir J (2008). Review of Regional and Pilot Area Consultations and Consistency of Scenario Development Approaches. SCENES Deliverable 2.3; IIASA, Laxenburg, Austria.

Linnerooth-Bayer J (2008). Non-insurance Mechanisms for Managing Climate-related Risks. In: *Mechanisms to Manage Financial Risks from Direct Impacts of Climate Change in Developing Countries*; FCCC/TP/2008/9, United Nations Office at Geneva, Geneva, Switzerland.
Linnerooth-Bayer J, Bals C & Mechler R (2008). Insurance Instruments for Adapting to Climate Risks: A Proposal for the Bali Action Plan. Germanwatch.
Linnerooth-Bayer J, Bals MJ & Mechler R (2008). Climate Insurance as part of a Post-Kyoto Adaptation Strategy. Germanwatch.
Linnerooth-Bayer J & Mechler R (2008). Insurance against Losses from Natural Disasters in Developing Countries. United Nations World Economic and Social Survey (WESS).
Mechler R (and The Risk to Resilience Study Team) (2008). The Cost-Benefit Analysis Methodology. In: M. Moench, E. Caspari, & A. Pokhrel (eds); *From Risk to Resilience* Working Paper No. 1; ISET-Nepal and ProVention, Kathmandu, Nepal, 34 pp.
Mechler R & Hochrainer S (2008). Preparing Madagascar for cyclones. Options; IIASA, Laxenburg, Austria p. 11.
Mechler R, Hochrainer S, Kull D, Chopre S, Singh P, Opitz-Stapleton S & Wajih S (2008). Uttar Pradesh Drought Cost-Benefit Analysis. In: M. Moench, E. Caspari and A. Pokhrel (eds); *From Risk to Resilience* Working Paper 5; ISET-Nepal and ProVention, Kathmandu, Nepal.
Moench M, Ahmed S, Mechler R & Kull D (et al.) (2008). Moving from Concepts to Practice: A Process and Methodology Summary for Identifying Effective Avenues for Risk Management under Changing Climatic Conditions. In: M. Moench, E. Caspari,& A. Pokhrel (eds); *From Risk to Resilience* Working Paper No.8; ISET, ISET-Nepal and ProVention, Kathmandu, Nepal, pp. 52.
Patt A (2008). Making climate forecasts useful in a changing climate. Options; IIASA, Laxenburg, Austria, pp. 24–25.

Policy Reports (Non-Peer-Reviewed)

Linnerooth-Bayer J, Bals C & Mechler R (2008). Climate Change: What Role for Insurance IIASA Policy Brief #4.

Conference Proceedings (Non-Peer-Reviewed)

Lasut A (2008). Costs and benefits of insurance against flood: Case study of Wisloka River Basin in Poland. In: *Proceedings, International Disaster and Risk Conference (IDRC)*. 25–29 August 2008, Davos, Switzerland.

Interim Reports (Non-Peer-Reviewed)

Compton KL, Faber R, Ermolieva T, Linnerooth-Bayer J & Nachtnebel H-P (2008). Development of a Catastrophe Model for Managing the Risks of Urban Flash Flooding in Vienna. IIASA Interim Report IR-08-001.

Transitions to New Technologies (TNT)

Journal Articles (Peer-Reviewed)

Cantono S & Silverberg G (2008). A percolation model of eco-innovation diffusion: The relationship between diffusion, learning economies and subsidies. *Technological Forecasting and Social Change*. (ENE)
Nakicenovic N (2008). The mobility drive. *e & i Elektrotechnik und Informationstechnik*, 125(11):362–366. (ENE)
O'Neill BC & Nakicenovic N (2008). Learning from global emissions scenarios. *Environmental Research Letters – Special Issue*, 3:045014. (PCC)
Rogner H-H, McDonald A & Riahi K (2008). Long-term performance targets for nuclear energy. Part 1: The global scenario context. *International Journal of Global Energy Issues*, 30(1–4):28–76. (ENE)
Rogner H-H, McDonald A & Riahi K (2008). Long-term performance targets for nuclear energy. Part 2: Markets and learning rates. *International Journal of Global Energy Issues*, 30(1–4):77–101. (ENE)
van Vuuren DP, Meinshausen M, Plattner G-K, Joos F, Riahi K, de la Chesnaye F, den Elzen MGJ, Fujino J, Jiang K, Nakicenovic N, Paltsev S, Reilly J, et al. (2008). Temperature increase of 21st century mitigation scenarios. Proceedings of the National Academy of Sciences of the United States of America, 105(40):15258–15262. (ENE)
van Vuuren DP & Riahi K (2008). Do recent emission trends imply higher emissions forever. *Climatic Change*, 1–12. (ENE)
Warr B, Schandl H & Ayres RU (2008). Long term trends in resource exergy consumption and useful work supplies in the UK, 1900 to 2000. *Ecological Economics*, 68(1–2):126–140. (INS)

Book Chapters (Peer-Reviewed)

Gruebler A (2008). Energy transitions. In: Cleveland Cutler J (ed.), *The Encyclopedia of Earth*. Environmental Information Coalition, National Council for Science and the Environment, Washington D.C., USA.
Ma T & Gruebler A (2008). The evolution of technological complexity: An agent-based simulation model of the global energy system. In: Golub A & Markandya A (eds), *Modeling Environment-Improving Technological Innovations under Uncertainty*. Routledge, London, UK, pp. 205–244.

Books (Peer-Reviewed)

Bernstein L, Bosch P, Canziani O, Chen Z, Christ R & Riahi K et al. (Core Writing Team) (2008). *IPCC, 2007: Climate Change 2007: Synthesis Report*. IPCC, Geneva, Switzerland. (ENE)

Other Publications (Peer-Reviewed)

Doll CNH (2008). CIESIN Thematic Guide to Night-time Light Remote Sensing and its Applications. CIESIN, Columbia University, Palisades, NY, USA.

Conference Proceedings (Peer-Reviewed)

Nakicenovic N (Contributor) (2008). Towards a post-carbon society: European research on economic incentives and social behaviour. In: *Proceedings, Towards a "Post-Carbon Society": European research on economic incentives and social behaviour.* 24 October 2008, Brussels, Belgium, pp. 54. (ENE)

Other Publications (Non-Peer-Reviewed)

Nakicenovic N (2008). The Changing World: Energy Perspectives and Climate Change. In: 10th Symposium on 'Energieinnovation: Energiewende'; 15–17 February 2008, Graz, Austria. (ENE)
Nakicenovic N (2008). The ChangingWorld: Energy Perspectives and Climate Change. In: Global Economic Symposium; 4–5 September 2008, Ploen Castle, Germany. (ENE)

Conference Proceedings (Non-Peer-Reviewed)

Ma T & Nakamori Y (2008). Modeling uncertainties of technological learning with stochastic optimization. In: *Proceedings, 9th International Symposium on Knowledge and Systems Sciences*. 11–12 December, Guangzhou, China, pp. 37–42.
Zhang L, Nie G, Ma T, Liu F & Shi Y (2008). An intelligent process-oriented knowledge management system between human, process and knowledge. In: *Proceedings, 9th International Symposium on Knowledge and Systems Sciences*. 11–12 December, Guangzhou, China, pp. 347–354.

Directorate (DIR)

Journal Articles (Peer-Reviewed)

Jawjit W, Kroeze C, Soontaranun W & Hordijk L (2008). Future trends in environmental impact of eucalyptus-based Kraft pulp industry in Thailand: a scenario analysis. *Environmental Science & Policy*, 11(6):545–561.
Neto B, Kroeze C, Hordijk L & Costa C (2008). Modelling the environmental impact of an aluminium pressure die casting plant and options for control. *Environmental Modelling & Software*, 23:147–168.

Institute Scholars (INS)

Journal Articles (Peer-Reviewed)

Ayres RU (2008). Sustainability economics: Where do we stand? *Ecological Economics*, 67(2):281–310.

Li J & Ayres RU (2008). Economic growth and development: Towards a catchup model. *Environmental and Resource Economics*, 40(1):1–36.

Liu Y, Villalba G, Ayres RU & Schroder H (2008). Global phosphorus flows and environmental impacts from a consumption perspective. *Journal of Industrial Ecology*, 87(3–4):229–247

Thompson M (2008). Clumsiness: Why isn't it as easy as falling off a log. *Innovation*, 21(3):205–216. (RAV)

Warr B, Schandl H & Ayres RU (2008). Long term trends in resource exergy consumption and useful work supplies in the UK, 1900 to 2000. *Ecological Economics*, 68(1–2):126–140. (TNT)

Books (Peer-Reviewed)

Thompson M (2008). *Organising and Disorganising. A Dynamic and Non-Linear Theory of Institutional Emergence and Its Implication*. Triarchy Press, Devon, United Kingdom. (RAV)

2008 Personnel Resources per IIASA Program

APD

Scientific Staff

Markus Amann (Austria), Program Leader
Hans Benzinger (Germany)
Imrich Bertok (Slovakia)
Jens-Uwe Borken (Germany)
Adam Chambers (USA)
Janusz Cofala (Poland)
Christopher Heyes (United Kingdom)
Lena Höglund Isaksson (Sweden)
Sebastian Klaassen (Austria)
Zbigniew Klimont (Poland)
Maciej Makowski (Poland)
Gregg Marland (USA)
Binh Nguyen (Vietnam)
Pallav Purohit (India)
Peter Rafaj (Slovakia)
Robert Sandler (Austria)
Wolfgang Schöpp (Austria)
Erich Striessnig (Austria)
Geza Toth (Hungary)
Fabian Wagner (Germany)
Wilfried Winiwarter (Austria)

YSSP

Jinsong Chen (China)
Maria Kristina Difs (Sweden)
Tahira Munir (Pakistan)
Win Trivitayanurak (Thailand)
Susanne Wagner (Germany)

Administrative Support

Margret Gottsleben (Germany)

DYN

Scientific Staff

Arkady Kryazhimskiy (Russia), Program Leader
Sergey Aseev (Russia)
John Casti (USA)
Alexey Davydov (Russia)
Brian Fath (USA)
Kateryna Gumeniuk (Ukraine)
Andrey Krasovskiy (Russia)
Yaroslav Minullin (Russia)
Tapio Palokangas (Finland)
Denis Pivovarchuk (Russia)
Elena Rovenskaya (Russia)
Alexander Tarasiev (Russia)

Colosio Fellow

Manuel Ortiz Moctezuma (Mexico)

YSSP

Roman Chechushkov (Russia)
Jung-Chen Huang (Taiwan)
Yulia Pavlova (Russia)
Jae Ho Shin (Republic of Korea)

Administrative Support

Angela Dowds (United Kingdom)

EEP

Scientific Staff

Ulf Dieckmann (Germany), Program Leader
Gergely Boza (Hungary)
Nils Brännström (Sweden)
Dorothy Dankel (USA)
Daniel Falster (Australia)
Varvara Fazalova (Russia)
Barbara Fischer (Austria)
Mikko Heino (Finland)
Fiona Johnston (Canada)
Adam Kun (Hungary)
Johan Metz (Netherlands)
Fabian Mollet (Switzerland)
Agnes Rettelbach (Germany)
Sergio Rinaldi (Italy)
Axel Roßberg (Germany)
Akira Sasaki (Japan)
Karl Sigmund (Austria)
Barbara Taborsky (Austria)

Postdoctoral Research Scholars

Mats Bodin (Sweden)
Per Johansson (Sweden)
Shuichi Matsumura (Japan)
Rupert Mazzucco (Austria)
Lars Östergren (Sweden)
Davnah Urbach (Switzerland)
Rebecca Whitlock (United Kingdom)

Mikhalevich Scholarship

Andries Richter (Netherlands)

YSSP

Minho Kang (Republic of Korea)
Leithen Mgonigle (Canada)
Jan Ohlberger (Germany)
Kenichi Okamoto (USA)
Joshua Payne (USA)
Tatsuya Sasaki (Japan)

Administrative Support

Melanie Wenighofer (Austria)

ENE/GEA

Scientific Staff

Keywan Riahi (Austria), Program Leader (acting)
Roberto Aguilera (Canada)
Patrick Bell (USA)
Cheol Hung Cho (Republic of Korea)

Gerald Davis (United Kingdom) GEA Council Co-President
Sei Fujisawa (Japan)
Jose Goldemberg (Brazil) GEA Council Co-President
Thomas Johansson (Sweden) GEA Co-Chair
Volker Krey (Germany)
Nebojsa Nakicenovic (Austria) GEA Director
Patrick Nussbaumer (Switzerland)
Martin Offutt (USA)
Shonali Pachauri (India)
Shilpa Rao-Skirbekk (India)
Atsumasa Sakai (Japan)
Niels Schulz (Germany)
Takahiro Shiga (Japan)
Erich Striessnig (Austria)
Manfred Strubegger (Austria)
Bing Zhu (China)

YSSP

Tommi Ekholm (Finland)
Yan Qin (China)
Ekundayo Shittu (Nigeria)

Administrative Support

Patricia Wagner (USA)

FOR

Scientific Staff

Anatoly Shvidenko (Russia), Program Leader (acting)
Kentaro Aoki (Japan)
Dimitrios Ballas (Greece)
Hannes Böttcher (Germany)
Andriy Bun (Ukraine)
Gui-Ying Cao (China)
Karl Franklin (Sweden)
Steffen Fritz (Germany)
Sabine Fuß (Germany)
Mykola Gusti (Ukraine)
Khrystyna Hamal (Ukraine)
Petr Havlik (Czech Republic)
Matthias Jonas (Germany)
Nikolay Khabarov (Russia)
Georg Kindermann (Austria)
Florian Kraxner (Austria)
Sylvain Leduc (France)
Ian McCallum (Canada)
Aline Mosnier (France)
Liudmila Mukhortova (Russia)
Karthikeyan Natarajan (India)
Sten Nilsson (Sweden)
Michael Obersteiner (Austria)
Ewald Rametsteiner (Austria)
Belinda Reyers (South Africa)
Felicjan Rydzak (Poland)
Dmitry Shchepashchenko (Russia)
Alexey Smirnov (Russia)
Vladimir Stolbovoi (Russia)
Jana Szolgayova (Slovakia)
Kwang-Il Tak (Canada)
Januarti Tjajadi (Indonesia)
Hao Wang (China)
Larry Willmore (Canada)

Postdoctoral Research Scholar

Patrick Fell (Sweden)

YSSP

Ekaterina Dolgova (Russia)
Ane Heggedal (Norway)
Pushpendra Rana (India)
Johannes Schmidt (Austria)
Tamara Shulgina (Russia)
Jacek Skoskiewicz (Poland)
Chisa Umemiya (Japan)
Wenji Zhou (China)

Administrative Support

Cynthia Festin (USA)
Sharon Jandl (United Kingdom)

GEN

Scientific Staff

John Casti (USA)
Sebastian Cody (United Kingdom)
Peter Jenkins (United Kingdom)
Chin-Min Lee (Republic of Korea)
Cesare Marchetti (Italy)
Mahendrakumar Shah (United Kingdom)
Chihiro Watanabe (Japan)

Administrative Support

Julia Beck (Austria)

GGI

Initiative Co-Leaders

Hannes Böttcher (Germany), Initiative Co-Leader
Samir K.C. (Nepal) Initiative Co-Leader
Forrest MacKellar (USA) Initiative Co-Leader
Reinhard Mechler (Germany) Initiative Co-Leader
Shonali Pachauri (India) Initiative Co-Leader
Anthony Patt (USA) Initiative Co-Leader
Sylvia Prieler (Austria) Initiative Co-Leader
Fabian Wagner (Germany) Initiative Co-Leader

Scientific Staff

Joanne Bayer (USA)
Jesus Crespo Cuaresma (Spain)
Christopher Doll (United Kingdom)
Tatiana Ermolieva (Austria)
Steffen Fritz (Germany)
Günther Fischer (Austria)
Stefan Hochrainer (Austria)
Zbigniew Klimont (Poland)
Daniel Kull (USA)
Wolfgang Lutz (Austria)
Gregg Marland (USA)
Georg Pflug (Austria)
Pallav Purohit (India)

Warren Sanderson (USA)
Wolfgang Schöpp (Austria)
Erich Striessnig (Austria)
Geza Toth (Hungary)
David Wiberg (USA)
Wilfried Winiwarter (Austria)

YSSP

Yingchun Li (China)
Yvonne Scholz (Germany)
Charles Wilson (United Kingdom)

HGC

Scientific Staff

Forrest MacKellar (USA), Project Leader
Clara Cohen (USA)
David Horlacher (USA)
Steven Ney (Germany)
Andrew Noymer (USA)
Isolde Prommer (Austria)

YSSP

Zachary Almquist (USA)

Administrative Support

Deirdre Zeller (Ireland)

IME

Scientific Staff

Marek Makowski (Poland), Project Leader
Alexei Gaivoronski (Norway)
Janusz Granat (Poland)
Shuo Liu (China)
Hongtao Ren (China)
Jacek Wojciechowski (Poland)
Yurii Yermoliev (Ukraine)

YSSP

Sayaka Kanata (Japan)
Adam Kiczko (Poland)
Shuo Liu (China)
Dongling Zhang (China)

Administrative Support

Sitti Amalia Priyatna (Indonesia)

INS

Robert Ayres (USA)
Michael Beck (United Kingdom)
Warren Sanderson (USA)
Michael Thompson (United Kingdom)
Yurii Yermoliev (Ukraine)

LUC

Scientific Staff

Günther Fischer (Austria), Program Leader
Tatiana Ermolieva (Austria)
Kateryna Gumeniuk (Ukraine)
Sylvia Prieler (Austria)
Huanguang Qiu (China)
Mahendrakumar Shah (United Kingdom)
Laixiang Sun (United Kingdom)
Ferenc Toth (Hungary)
Eva Tothne Hizsnyik (Hungary)
(France)sco Tubiello (USA)
Harrij van Velthuizen (Netherlands)
David Wiberg (USA)

Postdoctoral Research Scholar

Edmar Teixeira (Brazil)

YSSP

Stefan Berecz (Austria)
Janne Helin (Finland)
Flora Piasentin (Brazil)
Liangjie Xin (China)
Syed Zaidi (Pakistan)

Administrative Support

Cynthia Enzlberger-Vaughan (Austria)

PCC

Scientific Staff

Brian O'Neill (USA), Program Leader
Regina Fuchs (Austria)
Karl Gmeiner (Austria)
Nikolay Melnikov (Russia)
Shonali Pachauri (India)
Katarina Zigova (Slovakia)

Postdoctoral Research Scholar

Katsumasa Tanaka (Japan)

Administrative Support

Ekaterina Smirnova (Netherlands)

PIN

Scientific Staff

Rudolf Avenhaus (Germany)
Franz Cede (Austria)
Guy Olivier Faure (France)
Victor Kremenyuk (Russia)
Paul Meerts (Netherlands)
Ariel Penetrante (Philippines)
Gunnar Sjöstedt (Sweden)
William Zartmann (USA)

YSSP

Carolin Görzig (Germany)
Louise Van Schaik (Netherlands)

POP

Scientific Staff

Wolfgang Lutz (Austria), Program Leader
Bilal Barakat (Germany)
Jesus Crespo Cuaresma (Spain)
Victor Garcia Guerrero (Mexico)

Anne Goujon (France)
Samir K.C. (Nepal)
Tapas Mishra (India)
Warren Sanderson (USA)
Serguei Scherbov (Netherlands)
Vegard Skirbekk (Norway)
Marcin Stonawski (Poland)
Erich Striessnig (Austria)
Emma Terämä (Finland)
Muhammad Wazir (Pakistan)
Christopher Wilson (United Kingdom)

Postdoctoral Research Scholar

Erling Häggström Lundevaller (Sweden)

YSSP

Zachary Almquist (USA)
Monika Sawhney (India)
Pavlo Shevchuk (Ukraine)

Administrative Support

Marilyn Brandl (USA)
Ekaterina Smirnova (Netherlands)

RAV

Scientific Staff

Joanne Bayer (USA), Program Leader
Aniello Amendola (Italy)
Anna Dubel (Poland)
Stefan Hochrainer (Austria)
Harvir Kalirai (United Kingdom)
Juha Kämäri (Finland)
Mohammad Khan (Pakistan)
Nadejda Komendantova-Amann (Austria)
Daniel Kull (USA)
Piotr Magnuszewski (Poland)
Reinhard Mechler (Germany)
Unmesh Patnaik (India)
Anthony Patt (USA)
Georg Pflug (Austria)
Jan Sendzimir (USA)
Pablo Suarez Argentina
Michael Thompson (United Kingdom)
Keith Williges (USA)
Christoph Wolfsegger (Austria)

Postdoctoral Research Scholar

Jason Blackstock (Canada)

Peccei Scholarship

Marta Vicarelli (Italy)

YSSP

Paulina Hetman (Poland)
Koichi Mikami (Japan)
Saskia Werners (Netherlands)
Nancy Wozabal (India)

Administrative Support

Helene Pankl (Austria)
Jun Watabe (Japan)

TNT

Scientific Staff

Arnulf Grübler (Austria), Program Leader (acting)
Vadim Chirkov (Russia)
Tieju Ma (China)
Nebojsa Nakicenovic (Austria)
Keywan Riahi (Austria)
Gerald Silverberg (USA)
Daniel Steinberg (USA)

Postdoctoral Research Scholar

Christopher Doll (United Kingdom)

YSSP

James McNerney (USA)
Michel Müller (Switzerland)

Scientific Support

Peter Kolp (Austria)

Administrative Support

Katalin David (Australia)
Patricia Wagner (USA)

Summary

In 2008, **203** research scholars, research assistants, postdoctoral research scholars from 34 different countries worked at IIASA; holding full-time, part-time or short-term contracts.

Together, these 203 scientists contributed **111** person-years to IIASA's research.

(For all statisticians out there: in 2007, 192 scientists contributed 104 person-years.)