PROGRESS REPORT 2009

May 2010

Progress Report to IIASA's National Member Organizations and Governing Council on IIASA's Research and Other Activities in 2009

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

After my first full year as Director of IIASA, I am pleased to report on a successful year for the Institute, including a strengthening of ties with our National Member Organizations and international recognition for IIASA's research and standing in the scientific community.

Strategic Plan, 2011–2020

A major achievement of 2009 came mid-year with the approval by the IIASA Council of the Strategic Plan 2011–2020, *Research for a Changing World*, which was published in September. Three new main research areas for the upcoming decade were approved by the Council: 1) Energy and Climate Change; 2) Food and Water; and 3) Poverty and Equity. These will incorporate studies of the main drivers of global transformation, specifically: population growth and technological change, economic growth and globalization. Innovations in systems analysis, growing policy relevance,, and increased capacity building round out the research strategy for the next decade.

Ensuring the continuing strong impact of IIASA's work is a major task for the Institute. The preparatory work for the 2011–2020 Plan was particularly challenging, as it started under the shadow of the world economic "meltdown" of October 2008. It was apparent to IIASA from the start of the planning process that the global financial crisis had massive ramifications for human wellbeing, the environment, and the interlinked problems of climate change and energy resources. Modeling and analyzing these systemic risks in an integrated way was therefore an important part of IIASA's new research strategy. The successful completion of IIASA's research strategy in 2009 will be followed by a more detailed research and implementation plan to be completed in 2010.

External Collaboration

It was a watershed year, too, for building external relations between IIASA and other international organizations and research partners. With the 15th Conference of Parties (COP15) of the UN Framework Convention on Climate Change (UNFCC) aiming to negotiate a new climate agreement in December in Copenhagen, IIASA high-level advisory activity intensified. In May IIASA briefed the United Nations Secretary-General (SG) Ban Ki-moon on energy and climate change. In June the SG invited IIASA's Deputy Director, Nebojsa Nakicenovic, to join the UNSG Advisory Group on Energy and Climate Change, whose brief was to tackle energy issues critical to the development and implementation of a post-Kyoto climate change agreement. In September IIASA was invited to participate in the UN Leadership Forum on Climate Change to identify solutions for climate change mitigation and adaptation to take forward to the COP15 negotiations in Copenhagen.

At IIASA research on climate change cuts across all IIASA programs—with eight contributing directly to the Institute's dedicated Greenhouse Gas Initiative (GGI). Much of IIASA's research work in 2009 was COP15-oriented. Notably, the IIASA GAINS modeling tool was used extensively, both internally and by scientists and policymakers outside the Institute, to obtain up-to-date comparative information on countries' efforts to reduce greenhouse gases (GHGs) ahead of COP15 negotiations. Developing workable strategies to elaborate monitoring and financing schemes for Reducing Emissions from Deforestation and forest Degradation (REDD) was another major focus for IIASA. The Institute participated in many key COP15-related workshops, working groups, and meetings in the run-up to Copenhagen. At the climate change talks themselves, IIASA, with the Indian Energy and Resources Institute, co-hosted a well-attended side event on integrated climate science and policy approaches to inform decision making.

The Global Energy Assessment (GEA), co-founded by and headquartered at IIASA, also plays a large role in integrating energy and climate change research at IIASA and globally. A major GEA research focus was development in 2009 of the transformational energy scenarios that form the analytical backbone of the GEA. At the high-level International Energy Conference in June in Vienna, the GEA was recommended as the support structure to guide research, increase global knowledge, and support energy policy development on behalf of UN Energy. At COP15 Germany joined the GEA, citing its potential as one of most important tools for policymakers at this important juncture of major global challenges.

Major Scientific Contributions

There were a number of notable scientific achievements by IIASA in 2009, only a few of which can be mentioned here. IIASA and partners released a new online and DVD version of the Harmonized Soil Database (HWSD) with updates for several Congo Basin countries. This provides valuable information for policymakers addressing the emerging problems of carbon sequestration, agricultural expansion, and environmental protection.

IIASA-developed land-use models (GLOBIOM, G4M, EPIC) are providing support for policy development on avoided deforestation in the Congo Basin and more broadly, informing discussions on how to reward developing countries for protecting their forests.

An IIASA team, with local partners, which assessed the challenges and opportunities for disaster risk management and climate adaptation in India, Nepal, and Pakistan, found that disaster risk reduction can "pay," justifying public and donor investment.

A study involving IIASA and international colleagues, published in 2009, identified regional "hotspots" in sub-Saharan Africa where early policy and management intervention may avert future hunger.

IIASA contributed to a White Paper, discussed at the Arctic Ministerial Council and the International Melting Ice Conference

in Norway, which puts forward mitigation options for black carbon (or soot) as a means of reducing Arctic ice melt.

Capacity Building

Outreach and capacity building, particularly for developing countries, were priorities in 2009. Another successful Young Scientists Summer Program (YSSP) welcomed 53 young scientists from over 20 nations. YSSP co-hosted a keynote presentation by one of the world's leading environmentalists and first Executive Director of the UN Environment Programme, Maurice Strong. Fifteen postdoctoral researchers worked at IIASA in 2009. Other notable events were a hands-on training workshop for 25 policy advisors and national experts from Russia, Belarus, Moldova, China and nine Western European countries on the use and application of the GAINS model, as well as co-organization of a graduate summer school at Moscow State University to study modern mathematical approaches to the assessment of economic growth

Awards

We are proud to note several awards to IIASA scientists in 2009. Wolfgang Lutz was honored with the Mattei Dogan Award, a four-yearly grant for comparative demographic analysis by the International Union for the Scientific Study of Population.

Vegard Skirbekk was awarded the European Research Council's European Starting Independent Researcher Grant for a five-year study on how factors such as productivity, attitudes, and beliefs will change in Europe in the next 50 years.

Detlof von Winterfeldt was awarded the Gold Medal of the International Society for Multicriteria Decision Making (MCDM) at its bi-annual conference in Chengdu, China; Buzz Holling (IIASA Director 1981–1984) was appointed as an Officer of the Order of Canada; and Anatoly Shvidenko was awarded the Honorary Medal of Forestry Society by the Russian Union of Foresters.

IIASA scientists published prolifically in 172 peer-reviewed journals and books in 2009, served as editors for scientific journals and publications, and were leading members of science advisory boards and steering committees.

Expertise and experience in advanced systems analysis is IIASA's strength. In a rapidly transforming, interconnected, and complex world, I look forward to an increasing role for IIASA in developing science for effective policymaking.

Detlof von Winterfeldt
Director
May 2010

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 geo-physical 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 in 2009

The GAINS Tool for Comparing Countries' Efforts to Reduce GHG Emissions

One of the key issues in negotiations for a post-2012 agreement on climate change is how much industrialized (Annex-I) countries are willing to reduce their emissions of greenhouse gases (GHG). Only a deal that is fair in sharing the burden of cutting GHG emissions, reflects national circumstances, and minimizes the collective costs of tackling climate change will be sustainable. An open and transparent comparison of alternative schemes for sharing the burden among industrialized countries can help identify mutually agreeable targets.

In time for the 2009 climate negotiations APD completed its GAINS (GHG - Air pollution Interactions and Synergies) model which enables coherent international comparisons of the potentials and costs for emission control measures. The model estimates to what extent and at what cost GHG emissions could be reduced across countries and estimates the co-benefits for air pollution. The GAINS analysis includes all six greenhouse gases of the Kyoto Protocol, covers all anthropogenic sources included in the emission reporting to the United Nations Framework Convention on Climate Change (UNFCCC), and considers around 300 different national mitigation options. APD has implemented the model for 36 Annex-I countries of the UNFCCC (i.e., Australia, Canada, the 27 member states of the European Union, Japan, New Zealand, Norway, Switzerland, Russia, Ukraine, United States).

Comparison of Model Estimates of GHG Mitigation Potentials and Costs

In April 2009 APD organized a review workshop of the GAINS model at which scientific peers scrutinized methodology and evaluated model results. This was followed by a workshop that compared estimates of GHG mitigation potentials and costs of nine models, including models developed by Japan, the European Commission, the U.S. Environmental Protection Agency, the Organisation for Economic Co-operation and Development (OECD), the Australian government, and McKinsey. While models apply different methodologies and databases, the comparison found that apparent disagreements between estimates can be resolved by adjusting for differences in 1) cost concepts (engineering costs, private costs, social costs, with/without macro-economic feedbacks), 2) baseline assumptions (e.g., on future economic development, autonomous efficiency improvements,

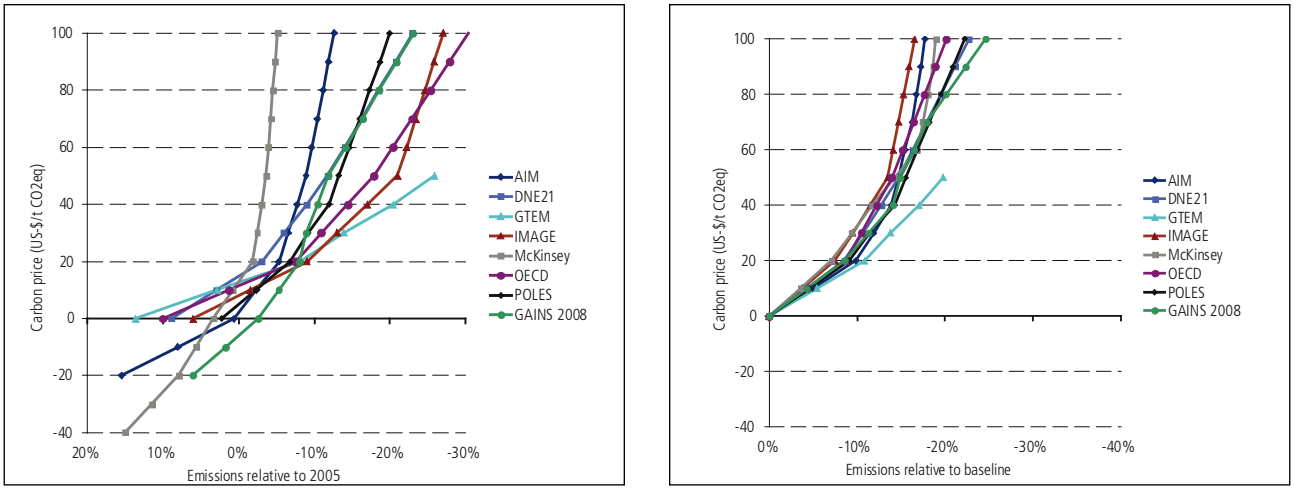

Figure 1. Once corrected for obvious differences in assumptions, model estimates agree on GHG mitigation potentials and costs. Left: Cost curves for GHG mitigation in Annex-I countries in 2020 as provided by models; Right: Corrected for different assumptions on cost concepts, baseline development, and implementation periods.

policy reference, etc.), and 3) assumed implementation periods (current models assume 5–15 years' implementation time up to 2020). These findings have been summarized in a joint paper co-authored by all workshop participants and presented to UNFCCC negotiators at a side event organized by IIASA at the UNFCCC Bonn Climate Talks in May 2009.

A subsequent review by OECD concluded that, "The only prominent international model of mitigation costs which provides sufficient country detail to form a basis for understanding comparability in the negotiating context is the GAINS model produced by IIASA. The GAINS model provides the most precise analytical basis for describing mitigation potential and costs across Annex I countries" (OECD 2009). APD was invited to present the findings to the OECD Ministerial Round Table on Sustainable Development (New York, 21 September 2009).

An Interactive Tool on the Internet

Based on the GAINS assessment of mitigation potentials and costs, APD has developed an interactive easy-to-use online calculator to help countries to compare mitigation efforts among Annex-I countries for a range of climate change commitments up to 2020. On a national level, the tool calculates the portfolio of emission control measures that achieve a certain climate change commitment at lowest cost. The tool is freely available on the Internet (http://gains.iiasa.ac.at/MEC). Furthermore, APD has developed interactive Web software that enables open access over the Internet to all underlying databases of all countries (http://gains.iiasa.ac.at). More than 25,000 external downloads of results pages have been registered by APD since the release of the software in April 2009.

Analysis of Pledges for the Copenhagen Climate Negotiations

As the GAINS tool enables comparison of mitigation efforts across countries, APD has produced a series of reports that explore mitigation costs of the pledges made by Annex-I countries for the Copenhagen negotiations. It was found that, as of December 2009, the pledges made by Annex-I countries would reduce their emissions by between 5 and 17 percent relative to 1990—less than the 25–40 percent reduction recommended by the Intergovernmental Panel on Climate Change (IPCC). Implied mitigation efforts are critically dependent on assumed economic development. For instance, the economic crisis has reduced economic activity, which in turn lowers GHG emissions. GAINS, updated with the latest 2009 projections on future energy use, suggests that if Annex-I countries were to take no further climate measures, their emissions would be 6 percent lower in 2020 than in 1990, compared to the 2 percent higher that was calculated using 2008 projections, thus leading to lower mitigation costs. Compared to an assumed increase of GDP in 2020 by 32–42 percent relative to 2005, costs would amount to <0.15 percent of GDP. However, higher upfront investments (<0.4% of GDP) would be required. These results were presented to the UNFCCC negotiators at an IIASA side event at the UNFCCC Barcelona Climate Talks in November 2009.

GAINS Policy Analyses in 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 (CLTAP) of the UN Economic Commission for Europe (UNECE). In 2009

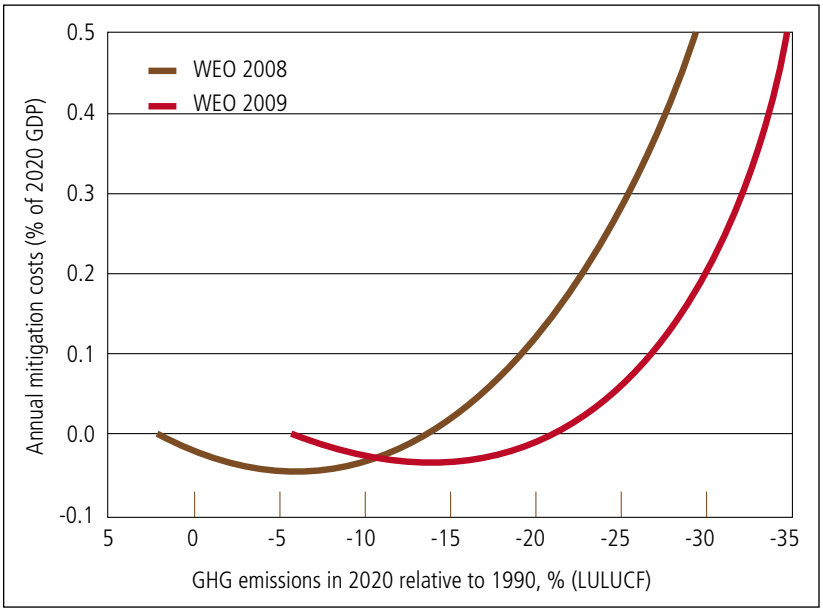

Figure 2. Estimates of future greenhouse mitigation potentials and costs are sensitive toward assumptions on economic growth. The figure shows how the economic downturn and other developments have lowered the annual mitigation costs for Annex 1 countries through changing greenhouse gas emissions. The results for the pre-economic crisis use data from the International Energy Agency's World Energy Outlook 2008. The results for the post-economic crisis have been updated with data from the World Energy Outlook (2009).

work at APD focused mainly on policy applications of the GAINS tool and on updating activity projections to reflect the recent economic crisis.

In 2009 GAINS analyses provided quantitative information to the European Commission to support the negotiations on the burden sharing of EU climate commitments. While the EU agreed in 2008 on a unilateral commitment to reduce their GHG emissions by 20 percent by 2020, analyses continued in 2009 on how a possible tightening of this target to a 30 percent reduction in the context of equivalent commitments of other countries could be implemented domestically. After extensive consultations with national experts, the GAINS model provided baseline activity projections for non-CO_2 gases for all member states and estimates of national mitigation potentials and costs.

CLTAP, which has officially designated IIASA as its Centre for Integrated Assessment Modelling, continued negotiations on the revision of its Gothenburg multi-pollutant/multi-effect Protocol. Negotiations explore, inter alia, ways of increasing participation of non-EU Parties to the Convention in Central and Eastern Europe, for which the complexity of the obligations laid down in current protocols have emerged as obstacles to implementation. The GAINS model is accepted by CLTAP as the central analytical tool. In 2009 work aimed at creating updated baseline projections reflecting the perspectives of all Parties, to provide a common starting point for policy analyses that will be conducted in 2010.

Policy Impact in 2009

APD members presented research results to a wide range of international policy meetings at different institutions:

- US-EPA workshop on "Near-term strategies for Slowing Warming in the Arctic" (Washington DC, 4 February 2009): "Methane emissions reduction potentials and costs"
- UNFCCC Plenary Workshop on "Issues relating to the scale of emission reductions to be achieved by Annex I Parties (Bonn, 27 March 2009) "GHG mitigation potentials and costs in Annex I countries"
- OECD Ministerial Round Table on Sustainable Development (New York, 21 September 2009): Statement on the quantification of mitigation potentials and costs
- European Commission, Climate Change Committee Working Group on "Implementation of the Effort Sharing Decision, Policies and Measures and Projections" (Brussels, 23 July and 24 September 2009): "Baseline projection of non-CO_2 greenhouse gas emissions"
- Senior Officials Meeting of North-East Asia Subregional Programme for Environmental Cooperation organized by UNESCAP and the Government of the Russian Federation (Moscow, 8–9 April 2009) "Co-benefits Approach to Greenhouse Gases and Air Pollutants"
- Convention on Long-range Transboundary Air Pollution:
  - Working Group on Strategies and Review (Geneva, 20–23 April 2009):
  - Working Group on Strategies and Review (Geneva, 21 August—3 September): "National baseline activity projections for the revision of the Gothenburg Protocol"
  - Executive Body (Geneva, 1–17 December 2009): "A concept for the inclusion of near-term radiative forcing into a multi-pollutant/multi-effect framework"
- IIASA side events at UNFCCC climate meetings:
  - UNFCCC Bonn Climate Talks (Bonn, 2 June 2009): "Comparison of estimates of GHG mitigation potentials and costs in Annex I countries"
  - UNFCCC Barcelona Climate Talks (Barcelona, 3 November 2009): "The impact of the economic crisis on GHG mitigation potentials and costs in Annex I countries"
  - UNFCCC COP15 (Copenhagen, 8 December 2009): "IIASA analysis of near-term mitigation potentials and costs in Annex I countries"

Activities for 2010

In 2010 APD will address the near-term impacts of air pollutants (e.g., black carbon, organic carbon, sulfate aerosols, and ground-level ozone) on regional radiative forcing and on black carbon deposition in the Arctic and on Alpine glaciers. Eventually this will allow emission reductions that are undertaken to control local air pollution to be adjusted in such a way as to minimize negative impacts on short-term radiative forcing. This information can also help to maximize synergies among emission control strategies for air pollutants and greenhouse gases.

APD will continue policy analyses with its GAINS model for the climate negotiations as well as for Europe and Asia.

Personnel Resources

Scientific Staff
Markus Amann (Austria), Program Leader
Hans Benzinger (Germany)
Imrich Bertok (Slovakia)
Jens Borken-Kleefeld (Germany)
Janusz Cofala (Poland)
Christopher Heyes (United Kingdom)
Lena Höglund Isaksson (Sweden)
Zbigniew Klimont (Poland)
Junji Nakazawa (Japan)
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
Erica Bickford (USA)
Sapana Gupta (India)
Abdul Jilani (Pakistan)
Gregor Kiesewetter (Austria)
Ekbordin Winijkul (Thailand)

Administrative Support
Margret Gottsleben (Germany)

Publications[1]

Journal Articles

ApSimon H, Amann M, Astroem S & Oxley T (2009). Synergies in addressing air quality and climate change. *Climate Policy*, 9(6):669-680 (November 2009).*

Baidya S & Borken-Kleefeld J (2009). Atmospheric emissions from road transportation in India. *Energy Policy*, 37(10):3812-3822 (October 2009).*

Birmili W, Alaviippola B, Hinneburg D, Knoth O, Tuch T, Borken-Kleefeld J & Schacht A (2009). Dispersion of traffic-related exhaust particles near the Berlin urban motorway – Estimation of fleet emission factors. *Atmospheric Chemistry and Physics*, 9(7):2355-2374 (2 April 2009).*

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Koch D, Schulz M, Kinne S & Klimont Z et al (2009). Evaluation of black carbon estimations in global aerosol models. *Atmospheric Chemistry and Physics*, 9(22):9001-9026 (27 November 2009). [GGI]*

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Purohit P (2009). Economic potential of biomass gasification projects under clean development mechanism in India. *Journal of Cleaner Production*, 17(2):181-193 (January 2009).*

Rypdal K, Rive N, Berntsen T, Fagerli H, Klimont Z, Mideksa TK & Fuglestvedt JS (2009). Climate and air quality-driven scenarios of ozone and aerosol precursor abatement. *Environmental Science & Policy*, 12(7):855-869 (November 2009).*

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1 *) Peer Reviewed
Highlighted publications appear more than once in the IIASA Publications List:
Dark brown entries: IIASA author collaborated with IIASA colleagues from different IIASA programs, identified in brackets.
Light brown entries: IIASA author researches for more than one IIASA program, identified in brackets.

Zhang Q, Streets DG, Carmichael GR, He KB, Huo H, Kannari A, Klimont Z, Park IS, Reddy S, Fu JS, Chen D, Duan L, Lei Y, Wang LT & Yao ZL (2009). Asian emissions in 2006 for the NASA INTEX-B mission. *Atmospheric Chemistry and Physics*, 9(14):5131-5153 (29 July 2009).*

Book Chapters

Amann M et al (2009). Air pollutants and greenhouse gases – Options and benefits from co-control. In: Pleijel H, Karlsson PE & Simpson D (eds), *Air Pollution & Climate Change – Two Sides of the Same Coin?* Swedish Environmental Protection Agency, Stockholm, Sweden, pp. 99-108.*

Other Publications

Amann M (2009). Co-benefits of Greenhouse Gas Mitigation Strategies on Human Health through Reduced Emissions of Air Pollutants. Final Report to Sponsor: World Health Organization, Rome, Italy (August 2009).

Amann M (2009). Comparing mitigation potentials and costs in Annex 1 countries in 2020 (Abstract). *IOP Conference Series: Earth and Environmental Science*, 6(58):582007 (1 February 2009).*

Amann M (2009). Integrated assessment tools: The Greenhouse and Air Pollution Interactions and Synergies (GAINS) model. In: *La pollution atmosphirique et le changement climatique*, Document GAPF, Paris, France, pp. 73-76.

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Garthwaite R, Fowler D, Stevenson D, Cox P, Ashmore M, Grennfelt P & Amann M et al (2009). Ground level ozone in the 21st century: Trends, interactions with climate and environmental impacts (Abstract). *IOP Conference Series: Earth and Environmental Science*, 6(28):282002 (1 February 2009).*

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Interim Reports

Amann M, Bertok I, Borken-Kleefeld J, Cofala J, Heyes C, Hoeglund Isaksson L, Klimont Z, Purohit P, Rafaj P, Schoepp W, Toth G, Wagner F & Winiwarter W (2009). Potentials and Costs for Greenhouse Gas Mitigation in Annex I Countries: Methodology. IIASA Interim Report IR-09-043.

Bickford E (2009). GHG Mitigation Potential in U.S. Transportation. IIASA Interim Report IR-09-045.

Borken-Kleefeld J, Cofala J & Rafaj P (2009). GHG Mitigation Potentials and Costs in the Transport Sector of Annex I Countries: Methodology, Version 2. IIASA Interim Report IR-09-039.

Cofala J, Purohit P, Rafaj P & Klimont Z (2009). GHG Mitigation Potentials from Energy Use and Industrial Sources in Annex I Countries: Methodology. IIASA Interim Report IR-09-040.

Ermolieva T, Winiwarter W, Fischer G, Cao G-Y, Klimont Z, Schoepp W, Li Y & Asman WAH (2009). Integrated Nitrogen Management in China. IIASA Interim Report IR-09-005. [FOR, GGI, LUC]

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Sanderson WC & Striessnig E (2009). Demography, Education, and the Future of Total Factor Productivity Growth. IIASA Interim Report IR-09-002.). [POP]

Wagner S & Klimont Z (2009). Exploring Implications of New EU Legislation for Animal Welfare and of Trends in Organic Farming on Ammonia Emissions. IIASA Interim Report IR-09-004.

Scientific Recognition

Markus Amann

- Member of the Clean Air Commission of the Austrian Academy of Sciences
- Member of the Scientific Steering Group of the Black Carbon Assessment of the United Nations Environment Programme (UNEP)

Invited lectures:

- Copenhagen Science Conference on "Climate Change: Global Risks, Challenges, Decisions" (Copenhagen, 10–12 March 2009): "Comparison of GHG mitigation efforts between Annex-1 countries"
- Symposium of the ACCENT Network of Excellence on Atmospheric Composition Change (Aveiro, Portugal, 11 February 2009) "Clean air and economic development: A policy-oriented analysis"
- Workshop on Air and Climate (Gothenburg, 19–21 October 2009): "Options for co-control of air pollution and GHG emissions over the next 20 years"
- Norwegian Institute for Air Research (NILU), 40-year Anniversary Symposium on "Climate and pollution: Challenges across boundaries" (Lillestrom, 15 October 2009): "Air pollutants and greenhouse gases: Co-controls and co-benefits"

Jens Borken

- Lead author for the ATTICA European Assessment of Transport Impacts on Climate Change and Ozone Depletion.

Invited lectures:

- Freightvision Forum (Brussels, 8–9 June 2009) "Mitigating Emissions of Greenhouse Gases – Costs and Options for Transport versus other Sectors"
- EU DG Enlargement Workshop on Mitigations Policies of Emissions from Road Transport (Ankara, 10 June 2009) "Emission mitigation potentials and costs for road transport"
- Technical University Munich Lecture Series, "Verkehr aktuell" (Munich, 27 November 2009) "Wieviel Klimaschutz zu welchem Preis? Technische Potenziale und Kosten im Vergleich der Sektoren"

Janusz Cofala

- Member of the Editorial Advisory Board of the International *Journal of Climate Change Strategies and Management*
- Peer reviewer of the IEA World Energy Outlook 2009

Zbigniew Klimont

- Member of the Global Emission Inventory Activity (GEIA) Steering Committee

Invited lectures:

- Global Emission Inventory Activity (GEIA) Conference (Oslo, 26–28 October 2009) "Recent trends and mid-term projections of air pollutants emissions in Asia"

Pallav Purohit

- Guest Editor of the special issue on *Atmospheric Pollution of the Sustainability Journal* (published by MDPI, Switzerland)
- Member of the Editorial Board of *Sustainability Journal*
- Member of the Editorial Board of *The Open Renewable Energy Journal* (published by Bentham Science Publishers Ltd. USA)

Wilfried Winiwarter

Invited lectures:

- University of Ljubljana (21 April 2009) "Biofuels, food and the greenhouse gas balance"
- University of Klagenfurt (22 April 2009) "Modellierung der Emissionen von Feinstaub in Österreich"
- Vienna University of Natural Resources and Applied Life Sciences (Vienna,11–12 May 2009) "Update of the Austrian PM emission inventory"
- European Nitrogen Assessment policy workshop (Brussels, 9–11 September 2009) "Future scenarios of nitrogen in Europe"
- Canadian Institute for Advanced Research (CIFAR) Workshop on "Humans Transforming the Ocean Nitrogen Cycle" (Montreal, 13–14 November 2009) "Using Integrated Assessment Models to project the N-cycle to 2100"

External Research Contracts above €10,000

Title	Funder	Date From	Date To	Total (€)	2009 (€)
ACCENT Atmospheric Composition Change: An European Network	European Commission, DG Research via Consiglio Nazionale Delle Ricerche (National Research Council)	01.03.2004	31.12.2009	487,502	14,376
NitroEurope The nitrogen cycle and its influence on the European greenhouse gas balance	European Commission, DG Research via Natural Environment Research Council (NERC) Centre for Ecology and Hydrology (CEH)	01.02.2006	31.01.2011	70,002	16,915
EC4 MACS European Consortium for Modelling of Air Pollution and Climate Strategies	European Commission, DG Environment, LIFE	01.02.2007	31.01.2012	1,979,946	411,766
EUCAARI European Integrated project on Aerosol Cloud Climate and Air Quality interactions	European Commission, DG Research via University of Helsinki	01.01.2007	31.12.2010	185,100	73,554
Energy and Climate System Modelling	European Commission, DG Environment via ECSM-National Technical University of Athens	01.04.2008	31.03.2010	110,000	33,000
Full Costs of Climate Change	European Commission, DG Research via Stockholm Environment Institute	01.12.2008	31.07.2011	81,836	20,476
CITYZEN megaCITY - Zoom for the Environment	European Commission, DG Environment via Norwegian Meteorological Institute	01.09.2008	31.08.2011	133,335	53,509
Post 2012 Model Application for Post 2012 Regime Global Policies and EU 27 Action	European Commission, DG Environment via Entec UK Ltd	01.09.2008	17.07.2010	142,238	70,725
GAINS_NL3 Further Development and Improvement of GAINS-NL	Netherlands Environmental Assessment Agency (PBL)	01.10.2008	30.09.2009	50,210	38,657
Reduction of Energy Consumption / CO2 Emission and Improvement of Air Quality in Asia	Toyota Motor Corporation	01.10.2008	15.03.2009	35,698	16,599
Global Energy Assessment Initiative	Swedish Environmental Research Insitute Ltd, IVL	01.08.2008	30.06.2009	38,550	19,482
Extrabudgetary contribution to EMEP for IAM activities in support of the revision of the Gothenburg Protocol	Norwegian Meteorological Institute	01.01.2009	31.07.2009	24,516	24,516
Implementing Instrument -- to collaborate for the purpose of implementing the 2008 workplan	United Nations Economic Commission for Europe (UNECE)	01.01.2009	31.03.2009	67,901	67,901
Memorandum of Agreement: 11th Workshop on the Transport of Air Pollutants in Asia - Model Intercomparison Study (MICS-Asia)	Acid Deposition and Oxidant Research Center (ADORC)	01.02.2009	31.03.2009	30,000	30,000
Agreement for Services to develop a common database, conduct workshop, expand collaboration	CATF - Clean Air Task Force	01.03.2009	31.12.2009	41,560	41,560
CIAM-EMEP-2009 Funds under the 2009 Implementing Instrument for the Cooperative programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollution in Europe	Norwegian Meteoroligical Institute (met.no)	01.01.2009	31.12.2009	116,251	116,251
Reduction of Energy Consumption/Co2 Emission and Improvement of Air Quality in Asia	Toyota Motor Corporation	01.04.2009	15.03.2010	42,500	33,319
Emission Trends	International Energy Agency (IEA)	27.05.2009	30.09.2009	10,000	10,000
Further integrated assessment modelling for the NEC Directive and the Gothenburg protocol	European Commission, DG Environment	26.05.2009	25.05.2011	124,973	33,042
Project Synergies between Adaptation and Mitigation: Assessing the potential of mutual co-effects (SynAdapt)	JOANNEUM RESEARCH Forschungsgesellschaft mbH	01.06.2009	31.03.2010	45,000	31,500
MoU between UNECE and IIASA: CLRTAP/2009 Integrated assessment modelling	United Nations Economic Commission for Europe (UNECE)	01.08.2009	31.12.2009	41,300	41,300
Contract for Upgrading RAINS_Italy to GAINS_Italy and Related Maintenance Services	Italian Agency for New Technology Energy and the Environment (ENEA)	01.11.2009	31.10.2011	70,001	15,512
EnerGEO Energy Observation for monitoring and assessment of the environmental impact of energy use	European Commission, DG Research via TNO-Netherlands Organisation for Applied Scientific Research	01.11.2009	31.10.2013	250,229	24,022
Small Scale Funding Agreement between UNEP and IIASA	United Nations Environmental Programme (UNEP)	15.12.2009	14.04.2010	32,501	2,147
Updating Annex I MACs to the WEO2009 baseline	Minstry of Housing, Spatial Planning and the Environment (VROM)	01.11.2009	28.02.2010	50,271	25,969

Evolution and Ecology Program

Ulf Dieckmann
dieckmann@iiasa.ac.at

Objectives

IIASA's Evolution and Ecology Program (EEP) analyzes and forecasts how ecological and evolutionary dynamics shape populations, communities, and ecosystems. Specific challenges addressed range from assessing and managing human-induced evolutionary changes in exploited fish stocks, to understanding the impact of environmental disturbances on the structure and functioning of food webs, and to fostering cooperation in groups of agents. 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 living systems.

The sections below briefly review EEP's research accomplishments in 2009, structured according to the Program's four main research projects, as established in EEP's research plan for 2006–2010.

Scientific Achievements in 2009

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 pursuit of this goal, EEP adopts a threefold approach as summarized below.

A first element is the development of innovative methodological tools suitable for tackling the new research questions. 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, 2009c), and adaptive dynamics models have been extended (Ernande *et al.*, in press). To understand the effects fishing exerts on adaptive traits, methods to quantify selection pressures have been refined (Arlinghaus *et al.*, 2009). To simultaneously estimate a set of life-history parameters, a novel method for estimating energy allocation from individual growth trajectories has been developed (Mollet *et al.*, 2010). To analyze trends in the maturation schedules of exploited fish stocks, so-called probabilistic maturation reaction norms have been introduced and estimated from data (Heino *et al.*, in revision).

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 2009, with dedicated studies targeting brook charr in Canadian lakes (Okamoto *et al.*, 2009), Arctic charr in Norway (Primicerio *et al.*, in revision), Atlantic salmon in the Baltic (Vainikka *et al.*, 2010), northern pike in Europe (Arlinghaus *et al.*, 2009), Atlantic cod in Iceland (Pardoe *et al.*, 2009), Atlantic cod in the Barents Sea (Eikeset *et al.*, in preparation), plaice in the North Sea (Mollet *et al.*, 2010, in preparation), chum salmon in Korea (Urbach *et al.*, in preparation), and sockeye salmon in Alaska (Kendall *et al.*, in preparation).

A third element is provided by strategic studies designed to address basic open questions regarding fisheries-induced evolution. Recent progress includes systematic investigations of the ecological and evolutionary aspects of recovery in collapsed fish stocks (Enberg *et al.*, 2009), an investigation of the propensity of marine reserves to slow the evolutionary effects of fishing (Dunlop *et al.*, 2009a; Miethe *et al.*, 2010), and new analyses of the practical implications of sex structure and mate choice for fisheries-induced evolution (Mollet *et al.*, in preparation). At a more fundamental level, investigations have examined the effects of predation and habitat characteristics on the recruitment of Atlantic salmon (Palm *et al.*, 2009) and how environmental feedback influences population characteristics of bull trout during a phase of recovery from over-fishing (Johnston and Post, 2009).

EEP's long-lasting 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 encyclopedias and magazines targeting broader groups of scientists and policymakers (Dieckmann, 2009; Dieckmann *et al.*, 2009; Heino and Dieckmann, 2009). Second, in autumn 2009 the Study Group on Fisheries-Induced Adaptive Change (SGFIAC), established in 2006 by the International Council for the Exploration of the Sea (ICES), was turned into a permanent expert group addressing scientific and applied dimensions of fisheries-induced evolution. Co-chaired by two of EEP's senior scientists, it is now referred to as the Working Group on Fisheries-Induced Evolution (WGEVO). During WGEVO annual meeting in 2009, the group summarized empirical evidence for fisheries-induced evolution (ICES, 2009), and continued the preparation of 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, a special issue from the symposium *Evolving Fish, Changing Fisheries* that EEP co-organized at the American Fisheries Society's annual conference in 2008 was published in the journal Evolutionary Applications (Dunlop *et al.*, 2009b), prominently showcasing four research contributions from EEP (Arlinghaus *et al.*, 2009; Dunlop *et al.*, 2009a; Enberg *et al.*, 2009; Okamoto *et al.*, 2009). Fourth, EEP was awarded a Theme Session entitled *Fisheries-induced adap-*

tive changes and their consequences: Why should we care, and what can we do? at the 2010 Annual Science Meeting of the International Council for the Exploration of the Sea.

Opening up a new line in EEP's research, methods are being devised for enabling the integrated assessments of fishery systems. One study investigated the role of technological evolution on fishery sustainability (Dercole *et al.*, 2010). To facilitate discussions on how to reconcile conflicting stakeholder preferences in fisheries management, EEP is developing a framework for the evaluation of joint stakeholder satisfaction based on multi-criteria utility functions (Dankel *et al.*, in preparation). In a similar vein, a new approach has been derived for the integrated socio-ecological assessment and management of recreationally exploited fish stocks that for accounts, the first time, for realistic complexity in angler behavior (Johnston *et al.*, 2010).

Evolution of Cooperation

EEP's research on the evolution of cooperation analyses conditions promoting cooperation in joint enterprises. This highly interdisciplinary research focus embraces issues as diverse as governing the commons in ecosystem management and the evolution of social norms in cooperative interactions among humans.

Several studies addressed how the evolution of cooperation is affected by complex behaviour and population structure in groups of interacting agents. Kun and Scheuring (2009) analyzed the effect of structured interactions on dynamical graphs on the promotion of cooperation. Nakamaru and Dieckmann (2009) used adaptive dynamics theory to investigate the gradual evolution of strictness and severity in enforcing cooperation. Arnold and Taborsky (2009) investigated the impact of social experience on the evolution of cooperative breeding in fish. Yahara *et al.* (2009) applied the theory of cooperation to selfish genetic elements. Uchida and Sigmund (2010) examined competition among different rules for assessing interactions between third parties; such rules, which can vary (e.g., in their level of sternness), are key to understanding indirect reciprocity. Sigmund and de Silva (2009) studied the role of opportunism in allowing both positive and negative incentives to boost cooperation. De Silva *et al.* (2010) investigated a strongly altruistic variant of the public-goods game and examined the role of voluntary participation in promoting the enforcement of cooperation. Traulsen *et al.* (2009) showed that high exploration rates promote both punishment and cooperation among self-interested agents in well mixed populations. A book review in the *American Scientist* (Sigmund 2009b) discussed the role of rationality assumptions in cooperation dynamics. Finally, a discussion paper by Sigmund (2009a) compared theoretical and experimental results on tag-based cooperation, which is based on the tendency of agents to favour individuals that are similar to themselves.

The monograph *Calculus of Selfishness* (Sigmund 2009c) investigates social dilemmas from the perspective of evolutionary game theory, focusing on well mixed populations and self-interested agents. Some chapters of the book deal with direct reciprocity, indirect reciprocity, positive and negative incentives, and the role of voluntary participation. Others review experimental games, game dynamics, and, very briefly, the evolution of cooperation in structured populations.

Adaptive Dynamics Theory

The EEP Program keeps developing the toolbox of adaptive dynamics theory at the front line of international research, delivering methods with wide applicability. Few assumptions are made other than a sufficient distinction in the timescales of ecological and evolutionary dynamics and a dominance of ecological over genetic determinants of adaptive change. The resultant line of concerted mathematical and applied research provides versatile tools for analyzing the complex interplay between population ecology, phenotypic evolution, and environmental change.

A main methodological advance has been the development of a new framework for the eco-genetic modeling of contemporary life-history evolution (Dunlop *et al.*, 2009c). Models of the new kind enhance the ecological detail of adaptive-dynamics models and complement it with the genetic detail of quantitative-genetics models, resulting in an approach that enables rates of evolutionary responses to anthropogenic environmental change to be predicted in carefully calibrated data-based models. In a similar vein, a novel procedure has been derived for evaluating the considerable selection pressures exerted by human harvesting of living resources (Arlinghaus *et al.*, 2009).

Another methodological improvement concerns our understanding of ecologically complex biodiversity dynamics in response to anthropogenic impacts (Johansson and Dieckmann 2009). Introducing the new concept of evolutionary domains of attraction, this work allows analysis and categorization of the long-term evolutionary responses through which ecological communities can recover from human-induced extinctions. A related study charted the extent to which temporal fluctuations in environmental conditions can obstruct evolutionary diversifications through the recurrent elimination of coexisting populations (Johansson *et al.*, 2009). Dercole and Rinaldi (2010) presented the first example of chaotic co-evolution.

Two applications of adaptive dynamics theory investigated the evolution of delayed germination and local specialization. Delayed germination, often the most critical determinant of plant population dynamics, allows plants to abate fluctuations in the environmental conditions encountered by seedlings. While classical theory was geared to arid climates, where environmental conditions fluctuate on large spatial scales, the newly developed understanding of the evolution of delayed germination is geared to the local fluctuations encountered in temperate climates (Metz *et al.*, 2009). A study of local specialization shows, for a systematically constructed set of simple model ecosystems, that evolutionary diversification in response to spatially heterogeneous environmental conditions becomes far more common when local adaptation evolves jointly with mobility (Ravigné *et al.*, 2009).

Evolving Biodiversity

In a study published in *Science*, Gross *et al.* (2009) reported 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. Rossberg *et al.* (2010) introduced a new method for modeling how trophic interaction strengths depend on functional traits, which is crucial for modeling and understanding the structure of ecological food webs. Elucidating the ecology and evolution of biodiversity in ecological communities, Heinz *et al.* (2009) studied speciation and the evolution of dispersal along environmental gradients, Taborsky *et al.* (2009) investigated size-assortative mating in the absence of mate choice, and Ravigné *et al.* (2009) showed how the joint evolution of habitat choice and local adaptation facilitates specialization and promotes diversity.

Several studies investigated the response of ecological populations and communities to disturbances. Johansson *et al.* (2010) studied how environmental fluctuation can impede biodiversity formation. Kun *et al.* (2009) demonstrated that the size of metapopulations is maximal on landscapes that are exposed to an intermediate frequency of disturbances. Fischer *et al.* (2009) uncovered unexpected patterns of skipped reproduction in environments with uncertain energy supply. Lin and Rinaldi (2009) derived statistical characteristics of vegetation patterns exposed to recurrent forest fires. Metz *et al.* (2009) demonstrated a new evolutionary explanation for germination strategies that buffer environmental fluctuations. Johansson and Dieckmann (2009) investigated evolutionary responses of communities to extinctions. Two further studies focused on population-level mechanisms that counteract environmental disturbances, by synchronizing populations across spatial scales (Belych *et al.*, 2009; Rinaldi, 2009; Fasani and Rinaldi 2010).

A study published in *Science* unraveled the phylogenetic origin of Europe's first farmers and hunter-gatherers (Bramanti *et al.*, 2009), and another phylogenetic investigation addressed the evolutionary transition from wolves to dogs (Pang *et al.*, 2009). Several investigations examined epidemiological dynamics, with a focus on influenza and herpes infections (Adams and Sasaki, 2009; Nakabayashi and Sasaki, 2009a, 2009b; Omori *et al.*, 2010).

Publications in 2009 also included research that advanced methods for dealing with complex population structure. Diekmann *et al.* (2009) introduced a new approach for investigating the stability of, and bifurcations in, the dynamics of physiologically structured populations. Based on a multi-scale maximum entropy approach, Raghib *et al.* (2010) developed a new method for approximating spatially structured plant population dynamics in continuous space. Matsumura *et al.* (2010) showed how the foraging of consumers on spatially distributed resources is affected by the sub-optimal movement of consumers between the locations of resources, by imperfect information about the status of these resources, and by the costs required for traveling between resource locations.

Policy Impact in 2009

EEP's research on the evolutionary dimensions of modern fisheries has been central to raising the international profile of this long-overlooked consequence of human exploitation. EEP has worked closely with the International Council for the Exploration of the Sea (headquartered in Copenhagen, Denmark), which is not only the main advisory agency for managing the North Atlantic Ocean and adjacent seas, but also the world's oldest intergovernmental organization concerned with marine and fisheries science. As a result of contributing to the ICES system of assessment and advice, the policy implications of fisheries-induced evolution have achieved international visibility and recognition. Since 2006 EEP's program leader has served as co-chair, together with two of EEP's close collaborators, of the ICES *Study Group on Fisheries-induced Adaptive Change* (SGFIAC). Recognizing this expert group's merits, it was upgraded in 2009 to a permanent status and is now known as the *Working Group on Fisheries-induced Evolution* (WGEVO). Currently, the group is developing frameworks for evolutionary impact assessment (EvoIA) in general, and for anticipating the effects of fisheries-induced evolution on the reference points that form the basis of all modern fisheries management. Based on WGEVO's work and written for a broad audience of fisheries scientists and managers, a report in the magazine ICES Insight titled *The Dawn of Darwinian Fisheries Management* (Dieckmann *et al.*, 2009) caused considerable interest and positive discussion at the ICES Annual Science Meeting in 2009.

Activities for 2010

Coordination and research efforts in 2010 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.
- Convening the first Annual Meeting of the *Working Group on Fisheries-induced Evolution* (WGEVO) of the International Council for the Exploration of the Sea (ICES).
- Convening the Theme Session *Fisheries-induced adaptive changes and their consequences: Why should we care, and what can we do?* at the 2010 Annual Science Meeting of the International Council for the Exploration of the Sea (ICES).
- 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 *First European Conference on Speciation Research*, as part of the Research Networking Programme Frontiers of Speciation Research (FroSpects), supported by the European Science Foundation.
- Co-organization of an international workshop on *Evolution of Divergence and Speciation Models of Specific Systems*, as part of the Research Networking Programme *Frontiers of Speciation Research* (FroSpects), 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).
- Research on systemic risk and network dynamics (in collaboration with IIASA's Dynamic Systems Program).
- Research on evolutionary-ecology vegetation models and, thereby, on an evolutionary foundation of dynamic global

vegetation models (in collaboration with IIASA's Forestry Program and Australian colleagues).
- Continued collaborative research with the YSSP award winners Daniel Falster (2006), Andries Richter (2007), Jan Ohlberger (2008), and Christian Hilbe (2009).
- Research on *Evolutionary Fisheries Management*, with a focus on integrated assessments, the design of harvest control rules, evaluating the expected rates of fisheries-induced evolution for specific stocks, refining eco-genetic models, developing innovative techniques for estimating maturation and ocean survival on anadromous fish, devising a general framework for evolutionary impact assessments, and evaluating the impact of fisheries-induced evolution on references points for fisheries management. This includes case studies on Caspian sturgeon (in collaboration with Russian and Iranian colleagues), Korean chum salmon and Pacific sardine (in collaboration with Korean colleagues), Alaskan sockeye salmon (in collaboration with colleagues from the United States), and orange roughy (in collaboration with Canadian colleagues).
- Research on *Evolution of Cooperation*, with a focus on investigating cooperation under resource heterogeneity, on understanding boom-bust cycles of irrational exuberance, and on elucidating the prevalence and consequence of the "tragedy of the commune".
- Research on *Adaptive Dynamics Theory*, with a focus on understanding multivariate evolutionary branching.
- Research on *Evolving Biodiversity*, with a focus on speciation dynamics, species packing, and community evolution.

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Personnel Resources

Scientific Staff

Ulf Dieckmann (Germany), Program Leader
Åke Brännström (Sweden)
Varvara Fazalova (Russia)
Barbara Fischer (Austria)
Mikko Heino (Finland)
Fiona Johnston (Canada)
Lise Marty (France)
Johan Metz (Netherlands)
Leithen M'Gonigle (Canada)
Fabian Mollet (Switzerland)
Johan Östergren (Sweden)
Heidi Pardoe (United Kingdom)
Joshua Payne (USA)
Agnes Rettelbach (Germany)
Sergio Rinaldi (Italy)
Tatsuya Sasaki (Japan)
Akira Sasaki (Japan)
Karl Sigmund (Austria)
Barbara Taborsky (Austria)

Postdoctoral Research Scholars

Mats Bodin (Sweden)
Jacob Johansson (Sweden)
Shuichi Matsumura (Japan)
Rupert Mazzucco (Austria)
Davnah Urbach (Switzerland)
Rebecca Whitlock (United Kingdom)

YSSP

Carl Boettiger (USA)
Christian Hilbe (Austria)
Marieke Jesse (Netherlands)
Magnus Lindh (Sweden)
Lise Marty (France)
Daisuke Takahashi (Japan)
Lei Wang (China)
Lai Zhang (China)

Adminstrative Support

Amalia Priyatna (Indonesia)
Melanie Wenighofer (Austria)

Publications[1]

Journal Articles

Adams B & Sasaki A (2009). Antigenic distance and cross-immunity, invasibility and coexistence of pathogen strains in an epidemiological model with discrete antigenic space. *Theoretical Population Biology*, 76(3):157-167 (November 2009).*

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Dunlop ES, Enberg K, Joergensen C & Heino M (2009). Toward Darwinian fisheries management (Editorial). *Evolutionary Applications*, 2(3):245-259 (August 2009).*
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Other Publications

Dieckmann U (2009). Fisheries-induced evolution. *The Parliament Magazine,* 288:22 (11 May 2009).
Dieckmann U, Heino M & Rijnsdorp A (2009). The dawn of Darwinian fishery management. *ICES Insight* (International Council for the Exploration of the Sea, Copenhagen Denmark), 46:34-43 (September 2009).
Heino M & Dieckmann U (2009). Fisheries-induced evolution. In: *Encyclopedia of Life Sciences*, John Wiley & Sons, Chichester, UK, Article A21213 (September 2009).*

Scientific Recognition

Editorships

Ulf Dieckmann

Theoretical Ecology

Mikko Heino

Ecology Letters

Johan A.J. Metz

Acta Biotheoretica

Akira Sasaki

Journal of Theoretical Biology

Karl Sigmund

Journal of Theoretical Biology, Theoretical Population Biology, International Journal of Bifurcation and Chaos, International Journal of Biomathematics, Philosophical Transactions of the Royal Society B

Barbara Taborsky

Ethology

Invited Lectures

Ulf Dieckmann

1. Faculty of Mathematics, University of Vienna, Austria: Runaway selection for cooperation and strict-and-severe punishment
2. Harvard University, Cambridge, USA, Workshop of the European Research Network on The Evolution of Cooperation and Trading (TECT): Runaway selection for cooperation and strict-and-severe punishment
3. University of British Colombia, Vancouver, Canada, International Conference of the Mathematical Biology and Annual Meeting of the Society for Mathematical Biology (SMB): Dynamics at the interface of ecology and evolution
4. Rønne, Denmark, Annual Meeting of the European Research Network Fisheries-induced Evolution (FinE): Fisheries-induced multi-trait evolution
5. Laxenburg, Austria, Conference "Evolution of Cooperation – Models and Theories" of the European Research Network on The Evolution of Cooperation and Trading (TECT): Runaway selection for cooperation and strict-and-severe punishment
6. Berlin, Germany, International Conference "Evolutionary Ecology of Fishes: Diversification, Adaptation and Speciation": The overlooked evolutionary dimension of modern fisheries
7. Palma de Mallorca, Spain, International Workshop"150 Years after Darwin: From Molecular Evolution to Language": Dynamics at the interface of ecology and evolution
8. Institute of Mathematical Methods in Economics, Vienna University of Technology, Vienna, Austria: Dynamics at the interface of ecology and evolution
9. University of Iceland, Reykjavik, Iceland, Workshop on "Atlantic cod: Intrastock diversity and implications for management": The overlooked evolutionary dimension of modern fisheries

Barbara Fischer

1. Swiss Federal Institute of Technology Zürich, Switzerland: When to store energy in a stochastic environment
2. Politecnico di Torini, Torino, Italy, Conference of the European Society for Evolutionary Biology: When to store energy in a

stochastic environment
3. University Bristol, Bristol, UK, Conference "Mathematical Models in Ecology and Evolution": Predicting optimal offspring size when adults and juveniles do not occupy the same niche

Mikko Heino

1. Horta, Portugal, ICES International Symposium on "Confronting the Deep Oceans": Catchability of pelagic trawls for sampling deep-living nekton in the mid-north Atlantic
2. Kristiansand, Norway, MAR-ECO International Project Workshop: Relationships between abundance, mean size, depth and latitude in mid-atlantic nekton
3. Warnemünde, Germany, ICES/PICES/UNCOVER Symposium on "Rebuilding Depleted Fish Stocks": Implications of fisheries-induced evolution for stock rebuilding and recovery
4. Berlin, Germany, International conference "Evolutionary Ecology of Fishes: Diversification, Adaptation and Speciation": Empirical evidence for fisheries-induced evolution in the wild
5. University of Iceland, Reykjavik, Iceland, Workshop on "Atlantic cod: Intra-stock diversity and the implications for management": Life history variation in Atlantic cod along the Norwegian coast
6. Rønne, Denmark, Annual Meeting of the European Research Network Fisheries-induced Evolution (FinE): 1) Fisheries-induced evolution changes in Atlantic cod in the Barents Sea; 2) Fisheries-induced evolution changes in Baltic salmon; 3) Comparative analysis and synthesis: Atlantic cod in Iceland, and gadoids in Masfjorden, Norway; 4) How do sexually dimorphic fish respond to harvesting? Insights from simple models; 5) Guppy experiments in Bergen

Jacob Johansson

1. Umeå University, Umeå, Sweden, Workshop on "Reproductive allocation schedules in plant communities": Optimal allocation to reproduction in plants
2. Mürren, Switzerland, Workshop on "Global Change and Plant Microevolution": Predicting strategic variation within plant communities: an evolutionary approach

Fiona Johnston

1. Copenhagen, Denmark, Annual meeting of the Study Group on Fisheries-Induced Adaptive Change (SGFIAC) of the International Council for the Exploration of the Sea (ICES): Recreational fish species life-history characteristics
2. Berlin, Germany, International conference "Evolutionary Ecology of Fishes: Diversification, Adaptation and Speciation": Rapid rebuilding of a recreational fish population after severe over-exploitation and the potential for harvest-induced evolution
3. Ijmuiden, Netherlands, Annual Meeting of the European Research Network Fisheries-induced Evolution (FinE): Integrating heterogeneous angler behaviour and fish population dynamics to determine socially optimal management
4. Palma de Mallorca, Spain, Workshop on "Adaptive Dynamics and Management of Coupled Social-Ecological Systems Exemplified by Recreational Fisheries": 1) Integrating the diversity and complexity of angler behaviour into recreational fisheries management models; 2) The importance of fisheries-induced evolution in recreational fisheries management: a modelling perspective; 3) Towards sustainable fisheries management: accounting for the human, ecological and evolutionary dimensions of recreational fisheries
5. Berlin, Germany, Annual Science Conference of the International Council for the Exploration of the Sea (ICES): 1) Demographic and life-history responses of an over-exploited bull trout population to changes in angling regulations; 2) Towards sustainable fisheries management: accounting for the human, ecological and evolutionary dimensions of recreational fisheries; 3) Rapid rebuilding of a recreational fish population after severe over-exploitation and the potential for harvest-induced evolution

Shuichi Matsumura

1. Copenhagen, Denmark, Annual meeting of the Study Group on Fisheries-Induced Adaptive Change (SGFIAC) of the International Council for "the Exploration of the Sea (ICES): 1) Standardization of selection differentials; 2) Quantifying selection strength on multiple life-history traits in pike
2. Palma de Mallorca, Spain, Workshop on "Adaptive Dynamics and Management of Coupled Social-Ecological Systems Exemplified by Recreational Fisheries": 1) Simulating fish-angler interactions at a landscape level based on empirical data on angler behaviour; 2) Estimating selection strength and evolutionary consequences caused by recreational fishing on multiple life-history traits in pike (*Esox lucius*)
3. Berlin, Germany, International Conference "Evolutionary Ecology of Fishes: Diversification, Adaptation and Speciation": Estimating selection strength and evolutionary consequences caused by recreational fishing on multiple life-history traits in pike (*Esox lucius*)

Rupert Mazzucco

1. Biomathematics Group, University of Helsinki, Helsinki, Finland: 1) Speciation and the evolution of dispersal strategies on environmental gradients; 2) The influence of boundary conditions on evolutionary branching

Johan A.J. Metz

1. International Centre for Mathematical Sciences, Edinburgh, UK, Workshop on "Stochastic Population Dynamics and Applica-

tions in Spatial Ecology": The canonical equation of adaptive dynamics for physiologically and spatially structured Mendelian populations: 1) The ecological theatre; 2) The adaptive play
2. Bath Institute for Complex Systems, University of Bath, Bath, UK, International Conference on "Mathematical Biology: Multiply Structured Biological Populations": Effective population sizes and the canonical equation of adaptive dynamics
3. Centro Internacional de Matemática, Lisbon, Portugal, Conference "The Mathematics of Darwin's Legacy": The geometry of macro-evolution: links between adaptive dynamics and evo-devo

Fabian Mollet

1. Rønne, Denmark, Annual Meeting of the European Research Network Fisheries-induced Evolution (FinE): 1) Modeling species specific life-history evolution; 2) Sex-specific dimensions of fisheries-induced evolution
2. Berlin, Germany, International Conference "Evolutionary Ecology of Fishes: Diversification, Adaptation and Speciation": Evolution of management scenarios under fisheries-induced evolution

Johan Östergren

1. Rønne, Denmark, Annual Meeting of the European Research Network Fisheries-induced Evolution (FinE): Eco-genetic modeling of fisheries impacts on Atlantic salmon: model description

Sergio Rinaldi

1. Alta Scuola Politecnica, Bardonecchia, Italy: The art of modeling

Akira Sasaki

1. Kyoto, Japan, Japan Science and Technology Agency Symposium on "Basic Research Programs": Innovative model of biological processes and its development
2. Japan Science and Technology Agency, Kobe, Hyogo, Symposium on "Basic Research Programs": Innovative model of biological processes and its development
3. Hayama, Kanagawa, Japan, "SOKENDAI International Symposium 2009": Constructing Sokendai Academic Networks

Karl Sigmund

1. Darwin Days, Oslo, Norway: Evolution of cooperation, especially in humans
2. Senior Academy, Krems University, Krems, Austria: Evolution of cooperation
3. Österreichische Akademie der Wissenschaften, Vienna, Austria: "Darwin und die Evolution der Kooperation"
4. Third Max-Planck Symposium, Harnack Haus, Berlin, Germany: Evolutionary biology
5. Deutsche Physiker Tagung, Dresden, Germany
6. University of Vienna, Vienna, Austria, Conference "Der Homo soziobiologicus": Evolution von Kooperation beim Menschen
7. Jacobs University, Bremen, Germany: Steps in evolution
8. Theoretical Physics Group, University of Manchester, Manchester, UK, Workshop on "Aspects of Complexity": Cooperation in joint enterprises: between freedom and enforcement
9. Laxenburg, Austria, Conference "Evolution of Cooperation – Models and Theories" of the European Research Network on The Evolution of Cooperation and Trading (TECT): Reputation, incentives, and moral assessment
10. Faculty of Mathematics, University of Vienna, Vienna, Austria: Menger, Gödel, Reidemeister
11. Österreichischer Wissenschaftstag, Semmering, Austria: "Evolution – Entwicklung und Dynamik in den Wissenschaften"
12. Palma de Mallorca, Spain, International Workshop"150 Years after Darwin: From Molecular Evolution to Language": The emergence of executive power
13. Urania, Vienna, Austria, Symposium on "Kurt Gödel, oder die Unvollständigkeit der Wissenschaft?": Kurt Gödel und der Wiener Kreis

Barbara Taborsky

1. Rennes, France, 31st International Ethological Conference
2. Adelboden, Switzerland, Symposium on "The Use of Vertebrate Model Systems to Study Social Evolution"

External Research Contracts above €10,000

Title	Funder	Date From	Date To	Total (€)	2009 (€)
FISHACE Fisheries-induced Adaptive Changes in Exploited Stocks	European Commission, DG Research	01.05.2005	30.04.2009	682,514	88,748
EVOMAT Evolution and Mathematics: Mathematical and Statistical Analysis of Ecological and Genetic Diversity	Vienna Science and Technology Fund (WWTF)	01.09.2005	30.06.2009	153,901	18,595
Influence of past and present environment on life history	Austrian Science Fund (FWF)	01.09.2006	28.02.2010	259,937	63,197
ADAPTFISH Adaptive Dynamics and Management of Coupled Social-Ecological Recreational Fisheries	Forschungsverbund Berlin e.V.	01.12.2006	31.12.2010	216,153	16,413
FinE Fisheries Induced Evolution	European Commission, DG Fisheries and Maritime Affairs	01.07.2007	30.06.2010	410,411	164,663
FinE Supplementary Funding	Federal Ministry for Science and Research (BMWF)	01.07.2007	30.06.2010	177,875	72,621
BIOCONTRACT Mutualisms, Contracts, Space and Dispersal	European Science Foundation	01.05.2008	30.04.2011	194,641	31,444
Frontiers of Speciation Research - External Administrative Costs	European Science Foundation (ESF)	01.05.2008	30.04.2013	10,000	2,167
Salary contribution for Agnes Rettelbach for research on formation of biodiversity in spatially heterogeneous ecological environments	Max F. Perutz Laboratories GmbH (MFPL)	01.01.2009	30.06.2010	27,084	13,465

Forestry Program

Sten Nilsson
nilsson@iiasa.ac.at

Anatoly Shvidenko
shvidenk@iiasa.ac.at

Introduction

Forest ecosystems are among the most important global natural resources. Forests cover about one-third of the Earth's surface and contain most of its biodiversity. Forests are crucial to the functioning of the Earth system, producing, among other things, food, energy, industrial raw materials, medicines, and many ecological/environmental services. They are also considered to widely affect global water systems. Two billion people are dependent on the forests in one way or another for survival; one billion of them, according to the World Bank, live in extreme poverty.

The world's forests are going through rapid changes in terms of surface energy balances, climate, timber availability, globalization, demographics, land-use change, dramatic economic conditions, and overall global change. Deforestation of about 13 million hectares annually during the last 15 years has contributed to about one-fifth of global anthropogenic greenhouse gas (GHG) emissions. There is insufficient forest governance in many countries. There is also a strong link between forest development, agriculture, and the bioenergy sector, leading to land-use conflicts in many regions of the world.

Policymakers and decision makers of the sector need to have an understanding of what these changes will mean for the future of the forest system.

Objectives

The overall objectives of the research efforts of IIASA's Forestry (FOR) Program during recent years have been a number of Key Challenges related to global change and forests. These address the question of how to manage the forest sector's interaction with other environmental and non-environmental sectors to 1) harmonize its geo- and biospheric services and, 2) at the same time, enable the forest sector to positively contribute to socio-economic development. This objective is addressed from different perspectives by the three Research Themes in FOR *(Figure 1)*.

The objective of the Forestry Program theme, "Greenhouse Gas Cycling and Terrestrial Ecosystems," is to contribute to a better understanding of the exchange of greenhouse gas (GHG) fluxes between terrestrial ecosystems and the atmosphere and to determine how such understanding can be steered through management decisions at various levels. The second theme, "Global Impacts of Forest Sector and Land-Use Development in Emerging Economies," addresses global impacts of the forests sectors in China, India, Brazil, Congo Basin, and the Koreas, respectively. The third theme, "International Governance of Forests," helps to improve international practices in forestry and to bring research results achieved in the Program into the sector's policy and governance processes.

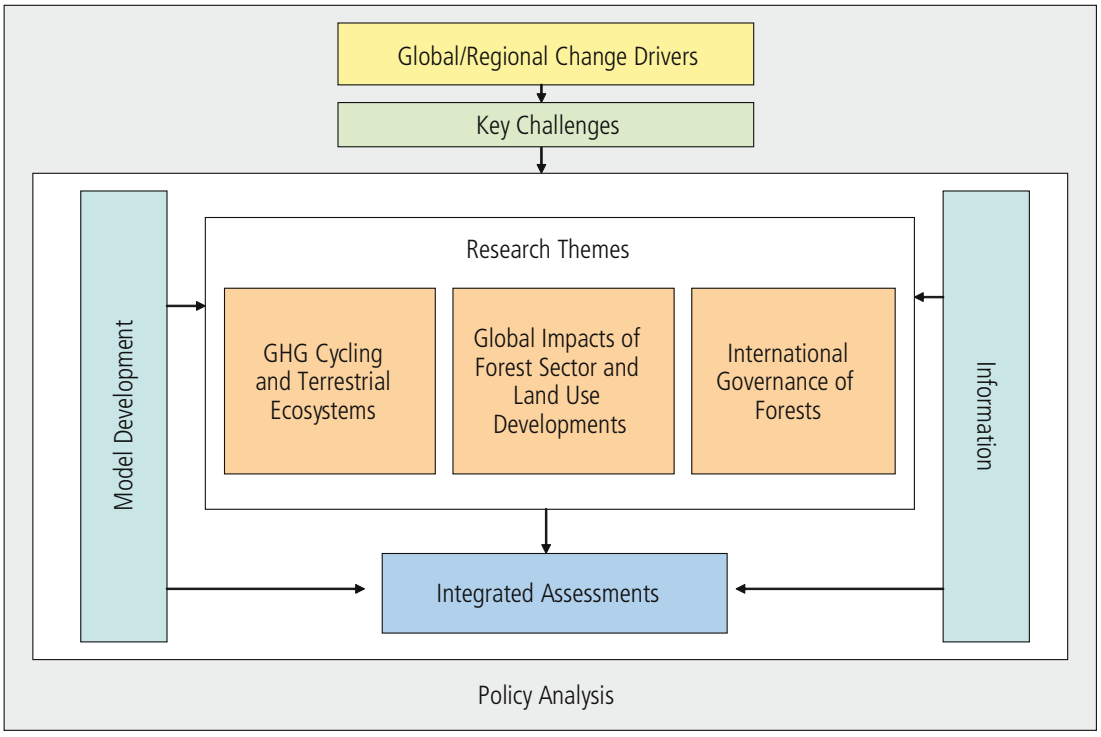

Figure 1. IIASA's FOR program research structure (Research Plan 2006-2010).

Scientific Achievements in 2009

During 2009 FOR worked on about 30 small- and large-scale projects. The Program was awarded 15 new projects that began in 2009 or will start at the beginning of 2010. The number of (peer-reviewed) publications during 2009 was 43 of a total of 57, including publications in high-level international journals such as Nature, *Science*, and *PNAS*.

Global Impacts of the Forest Sector and Land Use Development

Methodological issues

- Optimization principles rooted in ecology and evolution, looking at control of tree responses to environmental factors and climate change, are being introduced into forest models.
- FOR has published a new generic forest thinning model. The model can be applied to any forest and can be combined with a wide range of forest growth models.
- FOR has developed a pioneering microbial model that explains bacterial biomass C:N:P stoichiometry and macromolecular composition in relation to growth rate, based on optimal acclimation.

Land Use Change

- FOR enriched the global land use model GLOBIOM by an explicit livestock system representation with detailed GHG accounting (in collaboration with the International Livestock Research Institute [ILRI]).
- FOR analyzed the indirect land-use change effects of biofuel expansion—and demonstrated the potential benefits of trade in biofuels.
- Under the CC-TAME project, funded by the European Commission, the integration of irrigation system modeling into GLOBIOM was further developed (in collaboration with the University of Hamburg).
- FOR introduced into GLOBIOM bilateral trade costs (tariffs and transportation costs) differentiated among partners.
- Further development in linking the Forest and Agriculture Sector Optimization Model (FASOM) and GLOBIOM was carried out under the EC project EC4MACS.
- FOR conducted a regional application of high-resolution GLOBIOM to a Congo Basin deforestation analysis and obtained the first spatially explicit results with integrated local infrastructure scenarios.
- FOR provided further improvements of its Integrated Modeling Cluster with the aim of increasing the adequacy of the models and reducing their uncertainties. In particular, we identified drivers of deforestation and their impact, as well as the costs of Reduced Emissions from Deforestation and Forest Degradation (REDD).
- In the framework of an EC and World Bank study on REDD and the Congo Basin, FOR 1) established a database and developed biodiversity and infrastructure impact scenarios; 2) carried out an assessment of monitoring requirements and the costs of REDD; and 3) showed that overcoming initialization costs and unequal access to monitoring technologies is crucial for the implementation of an integrated monitoring system and to meeting demands for international cooperation.
- FOR's integrated global Ecosystem Assessment model cluster was used for regional policy analysis in Europe, North America, and the Congo Basin.
- FOR developed an easy-to-use graphical interface for its models (GLOBIOM, G4M). This tool aims to facilitate the communication of scientific results to end users, policy and decision makers, and will also serve FOR research needs.
- FOR models GLOBIOM and G4M were applied to project emissions and removals from the LULUCF sector to 2020 and 2030 (LULUCF tender to the EU).
- FOR produced a high resolution version of its Global Forest Model for Europe (EU-G4M)— an above-ground forest biomass map for Europe at a resolution of 1x1km and also performed work on its validation.
- The BEWHERE model was prepared for EU27 applications and now includes all biomass streams, including waste and residues from forestry and agriculture. The model was further developed with a detailed network infrastructure.
- FOR analyzed renewable energies, such as Jatropha for biodiesel production, at a competitive cost in India. The results of that research were ranked no. 20 in *Applied Energy*'s "hottest articles."
- FOR developed a global forest fire risk management model to estimate forest fire probability based on observed fires. This model has the capacity to predict forest fire risk for different climate scenarios.
- In the course of a new study on the impact of climate change on crop yield and undernutrition in sub-Saharan Africa (SSA), FOR has identified regional "hotspots" where early intervention using adaptive measures may avert future hunger and improve food security.

Global Earth Observations (GEO)

- FOR coordinated the three-year project GEOBENE, funded by the EC, which was successfully completed in June 2009 as the "world's first systematic study of the benefits of Global Earth Observation" (EC 2008).
- FOR carried out a study on a cross-border deforestation index to be used to understand the underlying drivers of deforestation in Africa, Latin America, and southeast Asia.
- FOR extended its real assets portfolio optimization methodology to introduce dynamics, allowing robust strategies in the face of socioeconomic and technological uncertainties to be determined.
- FOR developed a new application of its portfolio optimization methodology for crops and crop management under weather uncertainty.
- FOR further explored technological uncertainty with the real options method applied to energy issues.
- A beta version of the online global land cover validation tool Geo-Wiki.org was released, promoted widely, and validated by selected experts of the global GEO/GEOSS community. Geo-Wiki.org is an interactive Web interface which overlays global land cover products on Google Earth imagery and accepts validation of the products from volunteers.
- FOR developed a methodology for assessing the benefits of using geographic information layers derived from satellite

imagery for efficient disaster response. This is the first time that related quantifiable assessments have been carried out.
- FOR introduced the practical use of the Irkutsk Regional Information System for environment protection.

Greenhouse gas cycling and terrestrial ecosystems

- A new method for development of a hybrid land cover map for a large area (country, continent) was produced based on the systems integration of different information sources. The method was initially developed for the territory of Russia as an underlying dataset for the Terrestrial Ecosystems Verified Full Greenhouse Gas Account (FGGA).
- The FGGA methodology has been substantially enhanced and now includes 1) sets of empirical models for assessment of major components of the FGGA; 2) methods and models for assessing lateral carbon and nitrogen fluxes; 3) introduction of process-based elements in empirical models; and 4) a special expert system for elimination of biases in initial data.
- Based on a modified methodology and updated information, major indicators of productivity of Russian forests (live and dead biomass, net primary production [NPP], gross and net growth, mortality) have been reanalyzed. New estimates indicate increases in the productivity of Russian forests by 0.2–0.6 percent per year between the 1960s and 2009. The preliminary results show that previous estimates underestimated the net ecosystem carbon balance for Russian forests by 200–400 Tg C yr-1.
- From a review of satellite-based diagnostic NPP modeling, FOR derived several recommendations for improvement to current techniques. Furthermore, a comparison of satellite-derived FAPAR datasets (a key dataset used to determine vegetation productivity) noted large discrepancies in vegetation productivity in Northern Eurasia.
- Although the idea of FGGA is becoming more and more popular in scientific literature, policymakers and the international climate negotiations have so far been reluctant to use the concept on the basis that the uncertainties are too large and that a scheme would be too costly. Nilsson et al. (2008) and Shvidenko et al. (in press) have demonstrated that there are ways of providing FGGA at levels of uncertainties and cost that would be acceptable for policymaking.
- Impact of Uncertainty on Compliance and Emission Trading, a new educational tool, has been made available by FOR. It allows users to get a grasp of uncertainty and understand its impact on 1) compliance and 2) the amount of emission permits that can be traded under the Kyoto Protocol. The tool is accessible on the Web (http://www.iiasa.ac.at/Research/FOR/models/IUCET/index.html).

International governance of forests

- FOR carried out an evaluation of the process of the Ministerial Conference on Protection of the European Forests (Forests Europe, MCPFE). The evaluation demonstrates that MCPFE is at a crossroads and needs to undergo a major transformation to be relevant to European Forestry. The final report was presented to the stakeholders in late November at the Expert Meeting of MCPFE in Oslo. The report can be downloaded from the Forests Europe (MCPFE) home page: http://www.mcpfe.org/eng/Commitments/Documents/Meetings_2009/MCPFE+Expert+Level+Meeting.9UFRnO5S.ips.

Policy Impact in 2009

- FOR actively participated in COP15 in Copenhagen. FOR's research results were used for the negotiations by the EC and COP15. FOR: 1) supplied key figures to COP15 Climate Negotiations, 2) presented modeling tools for projecting LULUCF emissions, 3) participated in a number of side events, including a joint IIASA/ILRI side event on livestock and deforestation chaired by FAO.
- FOR's Geo-Wiki.org was featured in multiple side events at COP15.
- FOR actively participated in activities of the Group on Earth Observation as a member of the Science and Technology and User Interface Committees.
- FOR participated in the Copenhagen Consensus Project (www.fixtheclimate.com), the idea of which was to provide new estimates of costs and benefits of different options for tackling climate change. FOR participated in an expert panel to evaluate the options and give policy advice for Copenhagen.
- At the GEO-VI Plenary, the Sixth Plenary Session of the Group on Earth Observations, Steffen Fritz presented the Geo-Wiki.org (17–18 November 2009 Washington, DC, United States).
- FOR participated in the Global Environmental Change Agriculture and Food Security "GECAFS" (IIASA is lead author of a book chapter on Reconciling Global Environmental and Food Security).
- FOR participated in the "Foresight Project on Global Food and Farming Futures."
- FOR had bilateral progress meetings (in Austria and China) for the joint project on the Forest Land Reform in China (together with Beijing University).
- FOR organized the side event "Global Forests: Impacts on Major Global Biogeochemical Cycles" at the XIII World Forestry Congress, 18–25 October 2009, Buenos Aires, Argentina.
- Anatoly Shvidenko was appointed as an Expert for a Technical Assistance Mission for the Republic of Ukraine by the European Commission for Development of the National Forest Inventory System (19–23 January 2009).

Activities for 2010

In 2010 FOR plans to finish its 2006–2010 Research Plan (including ongoing projects) and prepare for transition to the new 2011–2015 Research Plan. Particular attention will be paid to further improvement of FOR's integrated modeling cluster and participation in advanced activities on remote sensing applications. FOR also plans to take an active part in activities on capacity building with a number of NMOs (India, Russia, and Ukraine). FOR will also participate in important international activities such as IPCC Fifth Assessment, UN Forest Forum, and others.

Global Impacts of Forest Sector and Land Use Development

Land Use Change

- Extension of deterministic models with uncertainty analysis and risk assessment.
- Research on integrating mitigation and adaptation options for sustainable livestock production under climate change—SICA (Latin America, African Mediterranean Partner Countries, African ACP).
- A comprehensive analysis of the impact of EU consumption of imported food and nonfood commodities and manufactured goods on deforestation.
- Research on greenhouse gas reduction through second-generation biofuels in Austria.
- Regional integrative assessment of bioenergy utilization paths based on spatial aspects —development of a model framework and a case study.

Global Earth Observations

- Participation in development of scientific background of a potential ESA mission "Biomass."
- Assessment of the benefits of the European Forest Fire Information System (EFFIS) based on stochastic optimization and simulation approaches. An appropriate approach needs to be developed based on the specifics of EFFIS and what compilation of data/knowledge is possible.
- Analysis of an early warning system's adaptation capacity in the context of future climatic pressures.

Greenhouse gas cycling and terrestrial ecosystems

- Finalization of the research on the Full GHG Analysis of Northern Eurasia's Terrestrial Biota, according to the FOR Scientific Research Plan.
- Bottom-up Inventory of the Carbon Fluxes in Northern Eurasia for Comparison with GOSAT Level 4 Products.
- Application of Geoinformation Technologies, Spatio-temporal Approaches, and Full Carbon Account for Improving Accuracy of GHG Inventories.
- Verified Full Greenhouse Account, adaptation and mitigation strategies: A comparative study for Austria and Russia.
- Assessment and Monitoring of Forest Resources in the Framework of the EU–Russian Space Dialogue.

International Governance of Forests

FOR plans to continue its work with the MCPFE (Ministerial Conference on the Protection of Forests in Europe).

General issues and program management

- Extension of the FOR Wiki to provide a better overview of projects and models within FOR.
- Establishment of a Web-based metadata server to provide an adequate means of organizing, accessing, and updating the information on large datasets that are produced/used internally and externally.

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Personnel Resources

Scientific Staff

Anatoly Shvidenko (Russia), Program Leader (acting)
Kentaro Aoki (Japan)
Hannes Böttcher (Germany)
Andriy Bun (Ukraine)
Gui-Ying Cao (China)
Karl Franklin (Sweden)
Steffen Fritz (Germany)
Sabine Fuß (Germany)
Mario Guevara Bonilla (Costa Rica)
Mykola Gusti (Ukraine)
Sarah Hall (Sweden)
Petr Havlik (Czech Republic)
Mario Herrero Acosta (Costa Rica)
Pabitra Jha (Nepal)
Matthias Jonas (Germany)
Nikolay Khabarov (Russia)
Georg Kindermann (Austria)
Florian Kraxner (Austria)
Sylvain Leduc (France)
Ian McCallum (Canada)
Aline Mosnier (France)
Sten Nilsson (Sweden)
Michael Obersteiner (Austria)
Christoph Perger (Austria)
Ewald Rametsteiner (Austria)
Felicjan Rydzak (Poland)
Dmitry Shchepashchenko (Russia)
Alexey Smirnov (Russia)
Vladimir Stolbovoi (Russia)
Jana Szolgayova (Slovakia)
Larry Willmore (Canada)
Bingzi Zhang (China)

Postdoctoral Research Scholar

Patrick Fell (Sweden)

YSSP

Constanze Haug (Germany)
Michael Hüttner (Germany)
Derek Lemoine (USA)
Myroslava Lesiv (Ukraine)
Franziska Strauss (Austria)
Margarita Strelkova (Russia)
Yun Wu (China)

Administrative Support

Cynthia Festin (USA)
Sharon Jandl (United Kingdom)

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Journals

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Dark brown entries: IIASA author collaborated with IIASA colleagues from different IIASA programs, identified in brackets.
Light brown entries: IIASA author researches for more than one IIASA program, identified in brackets.

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Scientific Recognition

Awards

- J. Szolgayova received a student award at the University of Bratislava.
- A. Shvidenko was awarded a Diploma for first place in the contest of results of scientific works by the Irkutsk Forest Management Agency (Russia) for the book "Dynamics of Forests of Irkutsk Region" (together with Dr. L. Vashchuk).
- S. Leduc was awarded a PhD after a successful defense of his thesis "Development of an Optimization Model for the Location of Biofuel Production Plants" based on his work at FOR (June 2009).

Advisory Boards and Editorships

- A. Shvidenko is on the editorial board of international journals *Forest Inventory and Planning*, *Mitigation and Adaptation Strategies for Global Change*, and *Scientific Herald of the Siberian Federal University*.
- A. Shvidenko is a Member of the Science Advisory Committee of the *Eurasian Journal of Forest Research*.
- M. Obersteiner and S. Nilsson are on the editorial board of the international journal *Carbon Balance and Management*.
- M Jonas is guest editor of a special issue of *Climatic Change* which is to appear in 2010. The special issue based on the 2nd International Workshop on Uncertainty in Greenhouse Gas Inventories, Laxenburg, Austria, 27–28 September 2007 http://www.ibspan.waw.pl/ghg2007/.
- L. Willmore is a contributing editor to Pension Reforms, a Web site of the Retirement Policy Research Centre, University of Auckland, New Zealand (www.PensionReforms.com).

Invited Lectures

Sten Nilsson

- Keynote address and leader of a special event on "Investments and financing of the forest sector" at the XIII World Forestry Congress (200 participants).
- Presentation to the Chairman of the Board and a number of directors of Jaakko Poyry (100 policymakers).
- Keynote speech on the transformation of the forest sector at the Wallenberg Prize Symposium, the EU chairmanship meeting with all EU director generals of forests, the Swiss Government symposium on future strategies on the forest sector, and the Paperweek Event in Brussels.
- Keynote speech on the issue of land-use conflicts and integrated land-use planning at the Tallberg Forum.

Anatoly Shvidenko

- Keynote presentation "Terrestrial ecosystems of northern Asia, global change, and post-Kyoto developments" at the International Conference Resource Economics, Environmental Economics and Climate Change – 2009, Krasnoyarsk, Russia, 1–7 July 2009.
- Keynote presentation (together with E. Gustafson, USA) "Forest forming process and dynamic vegetation models under global change" at the All-Russian Conference with International Participation, 23–25 September 2009, Krasnoyarsk.
- Presentation (with D. Schepaschenko, I.McCallum, R.A. Birdsey, D. McGuire, W. Kurz) "Impacts of forests of Northern extratropical belt on global carbon budget" at the XIII Forestry World Congress, 18–25 October 2009, Buenos Aires, Argentina.
- Presentation "Carbon models and data assimilation for boreal forests: Experiences from Northern Eurasia" at ESA-iLEAPS Scientific Consultation Workshop, 20 April 2009, Vienna, Austrian Academy of Sciences.
- Plenary presentation (with D. Schepaschenko, I. McCallum, A. Sukhinin) on "Impacts of vegetation fire in Russia on global carbon cycles in the past five years" at the International Conference CITES-2009, 11–15 July, Krasnoyarsk, Russia.
- Presentation (with D. Schepaschenko, I. McCallum, S. Nilsson, A. Sukhinin) "Carbon and nitrogen emissions due to vegetation fire in Russia in 2004-2008" at the EGU General Assembly 2009, 15–20 April 2009, Vienna, Austria.
- Co-presentation with D. Schepaschenko on "Northern Eurasian Ecosystems under global change: Distribution, state, vitality," at the First Workshop of NASA LCLUC Project, 7–9 December 2009, Cambridge, MA, USA.

Dmitry Schepaschenko

- Presentation (with I. McCallum, A. Shvidenko, F. Kraxner, S. Fritz): "A hybrid land cover dataset for Russia: A new methodology for merging statistics, remote sensing and in situ information" at the EGU General Assembly 2009, 15–20 April 2009, Vienna, Austria. Geophysical Research Abstracts, Vol. 11, EGU2009-6977, 2009.
- Presentation (with A. Shvidenko, I. McCallum): "Hybrid land cover for Russia as a background for studying the terrestrial ecosystems full greenhouse gas account" at the First Workshop of NASA LCLUC Project, 7–9 December 2009, Cambridge, MA, USA.

Sabine Fuss

- Talk on REDD and participated in panel discussion at the Royal Society in London, 9–10 November 2009.

Petr Havlík

Presentation on "Indirect land use change from biofuels: Modelling with GLOBIOM," DG Environment, Brussels, 30 June, 2009.

- Presentation on "Biofuels within a global multisectorial partial equilibrium model—GLOBIOM." Foresight-ERS-Farm Foundation Long Term Global Agricultural Modelling Workshop, Washington DC, 9-10 November 2009.

Nikolay Khabarov

- Talk on "The Value of Observations for Reduction of Earthquake-Induced Loss of Life on a Global Scale," at the United Nations International UN-SPIDER Workshop: Building Capacities to Reduce Disasters, Vienna, Austria, 2-4 June 2009.

Florian Kraxner

- Keynote speech at the North East Asian Ecology Forum in Yichun, China.

Michael Obersteiner

- Speech to the OECD on "Space technology, infrastructure and food supplies" of the OECD's futures program.
- Speech at Princeton University, "Feeding 9 Billion on a Hot Planet."
- Address to the Executive Committee of GEO on the socio-economic benefit assessment.
- Address to the Executive Committee of GEO at the Global Forest Carbon Tracking task in Thailand and participated in the Steering group for the Global Forest Observatory, June 2009.

Steffen Fritz

- Presentation on the "Cross-Border Deforestation Index (CBDI)" at the XIII World Forestry Congress.

External Research Contracts above €10,000

Title	Funder	Date From	Date To	Total (€)	2009 (€)
NitroEurope The nitrogen cycle and its influence on the European greenhouse gas balance	European Commission, DG Research via Natural Environment Research Council (NERC) Centre for Ecology and Hydrology (CEH)	01.02.2006	31.01.2011	81,000	4,990
GEO-BENE Global Earth Observation - Benefit Estimation: Now, Next and Emerging	European Commission, DG Research	01.07.2006	30.06.2009	908,063	164,384
EC4 MACS European Consortium for Modelling of Air Pollution and Climate Strategies	European Commission, DG Environment, LIFE	01.02.2007	31.01.2012	250,489	53,591
MIC-DIF Linking Microbial Diversity and Functions across Scales and Ecosystems	Austrian Science Fund (FWF)	01.05.2007	30.04.2010	101,272	32,737
GEO-BENE Supplementry Funding	Federal Ministry for Science and Research (BMWF)	21.03.2007	31.12.2009	373,958	61,820
BEE Biomass Energy Europe	European Commission, DG Research via Albert Ludwigs University (FELIS)	01.03.2008	30.11.2010	131,074	35,029
Full Costs of Climate Change	European Commission, DG Research via Stockholm Environment Institute	01.12.2008	31.07.2011	85,291	45,237
CCTAME Climate Change - Terrestrial Adaption and Mitigation in Europe	European Commission, DG Research	01.07.2008	30.06.2011	724,895	171,647
Post 2012 Model Application for Post 2012 Regime Global Policies and EU 27 Action	European Commission, DG Environment via Entec UK Ltd	01.09.2008	17.07.2010	69,621	57,294
QUATERMASS subcontract	Imperial College of Science, Technology and Medicine	01.10.2008	31.10.2009	66,697	51,108
Review of the MCPFE Process	Norsk Institutt for Skog og Landskap	20.01.2009	31.10.2009	128,800	128,800
CARBO Extreme The terrestrial Carbon cycle under Climate Variability and Extremes - a Pan-European synthesis	European Commission, DG Research via Max Planck Institute for Demographic Research	01.06.2009	31.05.2013	70,000	8,108
Study on the evolution of some deforestation drivers and their potential impacts on the cost of an avoiding deforestation scheme	ECORYS Nederland BV	01.03.2009	30.09.2009	50,220	50,220
Regional modeling of future GHG emissions from Deforestation and forest Degradation in the Congo Basin	The World Bank	01.06.2009	31.12.2010	131,401	98,087
BIOMASS FUTURES Biomass role in achieving the Climate Change & Renewables EU policy targets. Demand and Supply dynamics under the perspective stakeholders	European Commission, Executive Agency for Competitiveness and Innovation (EACI) Imperial College London	01.06.2009	30.11.2011	195,005	39,060
The Threat of Carbon Regulation and Business Hedging Strategy	Environmental Defense Fund (EDF)	01.03.2009	30.09.2009	30,000	30,000
Greenhouse Gas Reduction through Second Generation Biofuels in Austria	Kommunalkredit Public Consulting GmBH	01.09.2009	31.10.2010	106,285	21,646
Analysis of potential and costs of LULUCF use by EU member states	European Commission, DG Environment	01.10.2009	30.09.2010	130,006	40,076
EuroGEOSS A European Approach to GEOSS	European Commission, DG Research via Bureau de Recherches Géologiques et Minières (BRGM)	01.05.2009	30.04.2012	417,570	55,174
CCTAME Supplementary Funding	Bundesmnisterium fÃ¼r Wissenschaft und Forschung (BMWF)	25.11.2009	30.12.2011	67,312	67,312
GHG Europe Greenhouse gas management in European land use systems	European Commission, DG Research via Johann Heinrich von Thünen-Institute	01.12.2009	31.05.2013	300,000	4,703
LC-IMPACT Development and application of environmental Life Cycle Impact assessment Methods for imProved sustAinability Characterisation of Technologies	European Commission, DG Research via Stichting Katholieke Universiteit	01.12.2009	30.11.2012	308,061	2,923

Title	Funder	Date From	Date To	Total (€)	2009 (€)
PROSUITE Development and application of standardized methodology for the PROspective SUstaInability assessment of TEchnologies	European Commission, DG Research via Universiteit Utrecht	01.11.2009	31.10.2013	380,900	9,030
EnerGEO Energy Observation for monitoring and assessment of the environmental impact of energy use	European Commission, DG Research via TNO-Netherlands Organisation for Applied Scientific Research	01.11.2009	31.10.2013	382,185	12,518
PASHMINA Paradigm Shifts Modelling and Innovative Approaches	European Commission, DG Research Istituto di Studi per l'Integrazione dei Sistemi (ISIS)	01.11.2009	31.10.2012	319,300	2,725

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 for the production of food, animal feed, and bioenergy in order to achieve sustainability of land and water resources and safeguard food security, while at the same time promoting rural development.

A major scientific goal of LUC in 2009 was the development of improved and more effective tools and databases able to address the complex interlinkages between the volatile world food system, the rapid expansion of biofuel production, and climate change. LUC's research focused on the analysis of synergies and trade-offs of alternative uses of agro-resources and on providing spatially detailed understanding of alternative land and rural development options, as well as their associated social and environmental risks, including the impacts of climate change.

The LUC Program builds on established close interactions with relevant international organizations, ensuring that deliverables are of high policy relevance. International collaboration with leading climate change research institutions strengthens the Program's ability to deliver products with high scientific standards.

Scientific achievements

Food Security, Biofuel Expansion, and Climate Change

Scientific evidence has put the world on notice that in the 21st century, climate change is a real problem and that further delay in mitigation actions may not only result in substantially higher social costs but also put our planet's life-supporting capacity at risk in the long run. Since the early 1990s IIASA has been investigating the multiple dimensions of global change and contributing to assessments of the Intergovernmental Panel on Climate Change (IPCC) by exploring future development pathways and emission scenarios that have become the key elements for assessing global future climate change. LUC has developed a comprehensive modeling framework to spatially assess the interlinked impacts of climate change and biofuel expansion on agriculture and the world food system. Its experience is extensive; its first important study, commissioned by the United Nations, on the vulnerability of agriculture to climate change, was presented by IIASA at the World Summit on Sustainable Development in Johannesburg in 2002.

In 2009 LUC's global analysis framework was extended to report on Biofuels and Food Security, a very timely assessment as 1) many developed and developing nations were setting biofuel targets and mandates and 2) high food prices were causing an additional 100–200 million people to starve worldwide. Biofuel polices are intended to mitigate climate change, enhance energy security, and foster rural development. The results presented in the LUC study highlight the need for coordinated policies and regulation to ensure that efforts to address climate change and energy security challenges do not exacerbate the pressing problems of food insecurity and environmental degradation.

The final report of a study commissioned by the Organization of the Petroleum Exporting Countries (OPEC) Fund for International Development (OFID) and carried out by LUC was released during a side event at the meeting of the UN Commission on Sustainable Development (CSD17), organized jointly by IIASA, the Austrian government, and OFID in New York on 6 May 2009. OFID and OPEC included three articles on this study in their very widely distributed Bulletins in May 2009.

In preparation for the October 2009 High Level Expert Forum on "How to Feed the World in 2050" and the "World Summit on Food Security" (16–18 November 2009, Rome) an expert consultation was held at the Food and Agriculture Organization (FAO) in June 2009. LUC was invited to prepare and present a report entitled "How do climate change and bioenergy alter the long-term outlook for food, agriculture and resource availability?" The study conducted an integrated agro-ecological and socioeconomic spatial global assessment of the inter-linkages of emerging biofuel developments, food security, and climate change. The explicit purpose of the study was to quantify the extent to which climate change and expansion of biofuel production could alter the long-term outlook for food, agriculture, and resource availability developed by the FAO in its Agriculture Toward 2030/50 assessment.

The project "Efficient and Low-disturbing Biofuels Policies" (ELOBIO) (http://www.elobio.eu/), a 3-year project running to 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 that aim to reduce this disturbance. In 2009 ELOBIO organized the second and third stakeholder consultation, the second in the form of a

questionnaire and the final one as a workshop held in Brussels in November 2009. Results of the consultations were used as an input into LUC's ecological-economic modeling framework which assesses the impacts of accelerated biofuel deployment on food and feed markets.

The special issue of *Biomass and Bioenergy* 34(2) reports on a detailed integrated analysis carried out in the course of the "Renewable Fuels for a Sustainable Europe" (REFUEL) project, which has produced an EU road map for biofuels in transport. Researchers from LUC provided quantitative analysis of land-use dynamics, avoiding competition with food production, nature conservation, and other key ecological constraints. This research on Europe's biofuel production potentials included land productivity potentials for biofuel feedstocks and European land use scenarios. Key conclusions are that Europe will be able to produce the envisaged 10 percent target domestically, as soon as increases in productivity on existing cultivated land are achieved in Eastern Europe. The REFUEL project concludes that the development of economically viable alternative second-generation biofuels is essential for the sustainable long-term future of biofuels.

Policy Support for Sustainable Development of Agriculture and Rural Sectors

In support of and complementing the global studies, LUC has been conducting a number of regional projects; for example, in Ukraine, on agriculture and rural transformation in transition economies, 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, and specifically consider social development in rural areas and its implications for the resource base and ecosystems.

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

Within this CATSEI research framework, LUC has been responsible for the development of an innovative integrated modeling approach to the analysis of robust strategies for expansion of agricultural production consistent with food, water, and environment security goals. In 2009 the LUC team presented the model and results at several international conferences and in a number of peer-reviewed publications. The proposed framework accounts for supply-limiting factors like lack of land and water resources and on whether there is adequate infrastructure available; it also advises on robust production expansion based on social, economic, and environmental risk indicators. The explicit treatment of uncertainties and risks is an essential component of the framework. As an important element of the research, the LUC team with other CATSEI partners focused on assembling and reconciliation of a detailed county-specific database (at the level of about 3,000 administrative units) that includes information on population, agricultural activities, resources, and constraints in the locations for the 1997–2006 period. The methodologies and modeling tools developed include various data harmonization and (down/up) scaling algorithms.

At the 27th Conference of the International Association of Agricultural Economists in Beijing held from 16 to 22 August 2009, the CATSEI project organized a symposium with the title "Big events, big impacts in China in the 21st century: Trade, biofuels, and climate change and environment, land use, and poverty." The LUC Program with collaborators from the Chinese Centre for Agricultural Policies (CCAP) and the Amsterdam-based Centre for World Food Studies (SOW-VU), presented a paper developed under the LUC-led Work Package of CATSEI on "Environmental risks and impacts of China's agriculture" addressing the topics of climate change, modeling the risks of crop damage due to ground-level ozone, and management of agricultural nitrogen surplus and emissions.

The project on "Integrated Nitrogen Management in China" (INMIC), carried out under the umbrella of IIASA's Greenhouse Gas Initiative (GGI), was a collaborative effort between the LUC the Atmospheric Pollution and Economic Development Program (APD), and the Forestry Program (FOR). INMIC is intended to support integrated planning of allocation and production regimes of crops and livestock in China and to address the dilemma between inevitable production intensification and the need to preserve local quality of air, water, and soil. The project provided synergies and integrated CATSEI and GAINS methodologies to account for nutrients, especially nitrogen flows and GHG emissions from agricultural practices to the environment.

Results from the study point to agricultural practices that could achieve a trade-off between the benefits of economic development and local environmental conditions measured in terms of active greenhouse gas emissions and water pollution through leaching to groundwater. The study estimated that it is possible to increase agricultural production substantially during the next 30 years while keeping current levels of nitrogen discharge to soil, water, and air at the local scale. Under such management, compared to the business-as-usual case, emissions of nitrous oxide (N_2O) greenhouse gas emissions would be 25 percent lower.

In 2009, based on the results obtained and concepts developed during 2008–2009, an IIASA interim report, a peer-reviewed journal publication, and three conference papers were produced. The publication of project results in the summer 2009 issue of IIASA's *Options* magazine attracted the attention of the United Nations Environment Programme (UNEP), which request-

ed permission to publish an INMIC graphic in the UNEP Year Book, 2010.

The project "Water Scenarios for Europe and for Neighboring States" (SCENES) is a 4-year EC 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 in SCENES centers around driving forces. For instance, LUC has developed new innovative methodologies for quantifying national-scale scenario projections of water-cycle driving forces based on a stakeholder-driven participatory process. Experience with the panel process has indicated that, for certain drivers, the questionnaire and associated translation key—which were created using a fuzzy set analysis of panel members' responses—sometimes produced quantifications that were inconsistent with the assumed underlying storylines developed by the panel and also could not always be accepted by experts in those fields as falling within plausible ranges. Faced with this problem, LUC developed a new approach to producing consistent European projections of population, GDP, energy, and land use based on optimization methods to 1) balance the expert panel members' regional estimated growth values with the logic of the storylines, while 2) imposing limits for acceptable parameter ranges, for instance, to fertility, mortality, and migration rates set by population experts.

The project on "Agro-ecological Assessment for the Transition of the Agricultural Sector in Ukraine" aimed to develop a comprehensive picture of land use and agriculture, including an assessment of land resources for current and future climatic conditions. The aim of the project is to provide the basis for further development and elaboration of integrated strategies and policies toward an environmentally sustainable and internationally competitive agricultural sector. The second paper in a series of three reports on "Agro-ecological Assessment for the Transition of the Agricultural Sector in Ukraine" was finished in 2009. This report "Land Resources and Agricultural Productivity: Methodology and Results for Base Line Climate" provides an inventory of natural resources and an evaluation of biophysical limitations and potentials of crop production in Ukraine at the national, regional and sub-regional levels. The report was prepared as a joint study between IIASA and the Institute of Economics and Forecasting (IEF) of the National Academy of Sciences (NAS) of Ukraine, (IIASA's Ukrainian NMO).

The concepts and modeling approach to "robust agricultural planning" developed in INMIC-CATSEI were adopted and expanded in 2009 to study food security and the socioeconomic aspects of sustainable rural development in Ukraine. With the help of a Ukrainian participant in the 2009 Young Scientists Summer Program, Olexandra Borodina, supported by the IEF, a model-based analysis was conducted to identify the consequences of agriculture reforms in Ukraine. Ensuring food security, socioeconomic sustainability, and environmental safety are the key issues for long-term rural development in Ukraine. The results were presented to the Ukrainian NMO, the IEF Council, and at the IIASA conference on Coping with Uncertainties, 2009.

Sustainability issues are also at the core of the project on "Integration of Mainstream Economic Indicators with Sustainable Development Objectives" (IN-STREAM). Though mainstream economic measures such as GDP are useful and have great influence on both public and private decisions, they are flawed as a measure of human welfare. They also give little information as to whether economic activity is helping Europe make progress toward its environmental goals and its commitment to sustainable development. LUC is one of eight partners in IN-STREAM, a 3-year EC-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. LUC's contribution in 2009 was to 1) review previous modeling and statistical work that has attempted to bridge the gap between macroeconomic indicators and sustainability measures and 2) prepare a summary report on "Literature findings and recommendations for link-

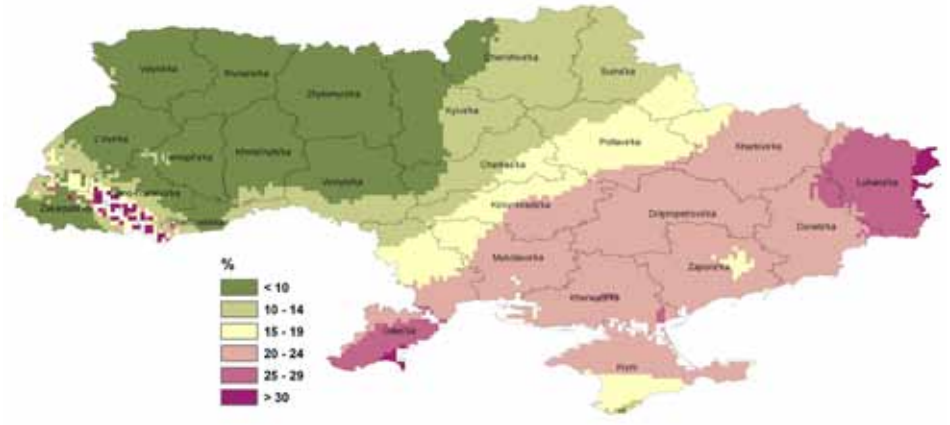


Figure 1. AEZ model-simulated coefficient of variation of rain-fed winter wheat yields for the period 1971–2000 (see Agro-ecological Assessment for the Transition of the Agricultural Sector in Ukraine)

ing sustainable development and mainstream macroeconomic indicators." Based on IN-STREAM analyses, recommendations for new indicator approaches will be proposed and strategies for implementing these approaches identified and developed in consultation with stakeholders.

Land Resources and Agro-ecological Zoning

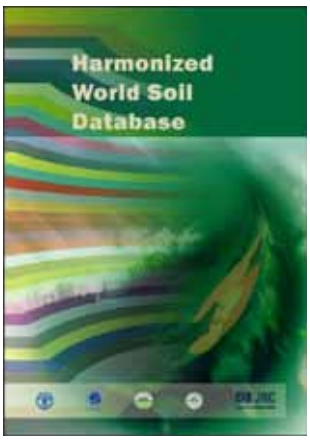
In 2009 IIASA, with support from FAO, completed a major update and expansion of the 2002 Global Agro-ecological Assessment for Agriculture in the 21st century. The updated study, referred to as GAEZ-2009, will be released in spring 2010.

GAEZ 2009

The GAEZ model framework developed and implemented at IIASA includes: 1) detailed spatial data of crop potentials for historical, baseline, and future climate scenarios, 2) spatially detailed estimates of actual crop yields and production, and 3) based on 1) and 2) quantification of prevailing yield gaps, all at 5 arc-minute global resolution (an approximately 10 km grid at the equator).

The Web-based data query and access system developed by LUC provides results for current climate and for the future climate of the 2020s, 2050s, and 2080s; the latter are currently based on four general circulation models (GCMs) (Hadley, Max Planck, Canadian, CSIRO). In total the system includes 34 combinations of time period/GCM scenario, each calculated for three input levels.

Several terabytes of data will be accessible to anybody with Web access. In addition, a complete set of GAEZ output files from runs using historical time series of climate data and for various climate change scenarios is stored on the server, and is available for further processing and analysis in future applications.



A first Version 1.0 of a new comprehensive Harmonized World Soil Database (HWSD) was jointly released by IIASA and FAO in July 2008. An updated version of the HWSD was uploaded in March 2009. Soter-based soil parameter estimates for D. R. Congo, Burundi, Rwanda, Senegal, and Gambia have been included. The data for this HWSD update were made available by the International Soil Reference and Information Center (ISRIC). The HWSD database can be downloaded at: www.iiasa.ac.at/Research/LUC/luc07/External-World-soil-database.

Based on the latest resource information, including the Harmonized Global Soil Resources Database and outputs of GAEZ-2009, the FAO provided a financial contribution in support of producing selected global indicators of land degradation for the LADA (Land Degradation Assessment in Drylands) project, including inventories of 1970–2000 historic agro-climatic trends and variability (historic length of growing period, aridity index, Fournier index), soil erodibility and erosion risk maps, and a management intensity index map comparing actual yields of 2000 (GAEZ 2009, downscaled agricultural statistics) to potential low input yields (GAEZ 2009, crop potentials) of dominant crops.

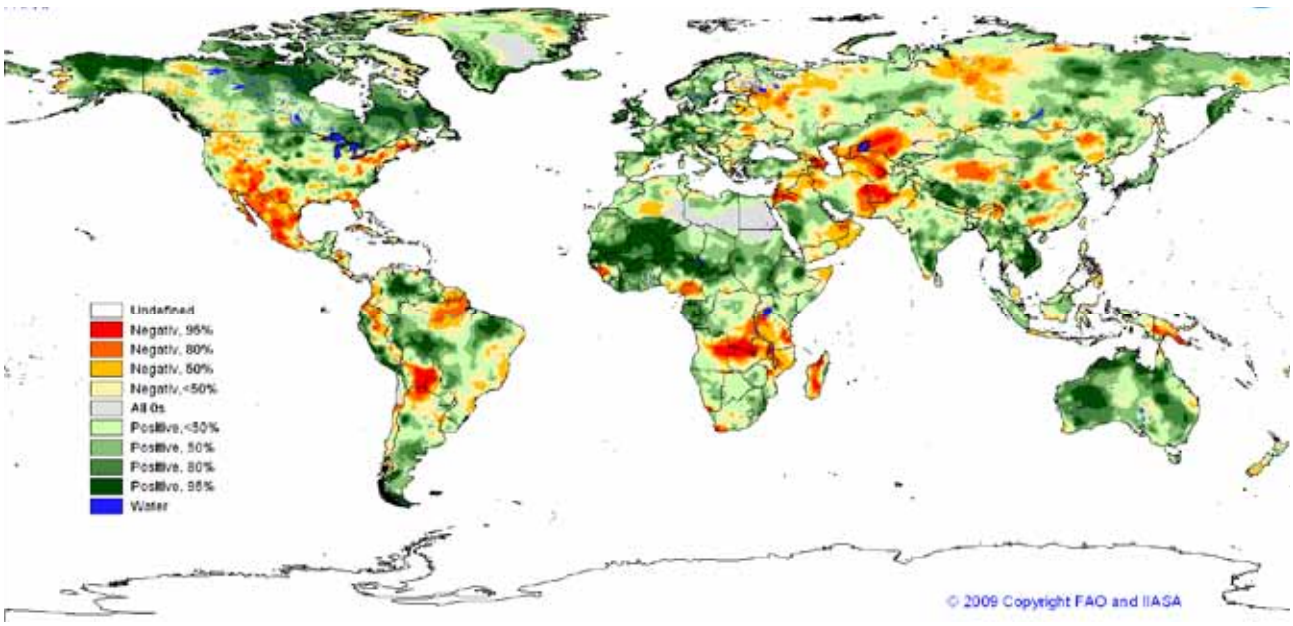


Figure 2. Direction and significance level of 1980–2000 trend in NPP

Personnel Resources:

Scientific staff

Günther Fischer (Austria), Program Leader
Tatiana Ermolieva (Austria)
Kateryna Gumeniuk (Ukraine)
Sylvia Prieler (Austria)
Huanguang Qiu (China)
Laixiang Sun (United Kingdom)
Ferenc Toth (Hungary)
Eva Tothne Hizsnyik (Hungary)
Harrij van Velthuizen (Netherlands)
David Wiberg (USA)

Postdoctoral research scholar

Edmar Teixeira (Brazil)

YSSP

Faheem Iqbal (Pakistan)
Marie Christine Lasco (Philippines)
Donald Midoko Iponga (Gabon)
Keshav Paudel (Nepal)

Scientific support

Bartosz Kozlowski (Poland)

Administrative support

Cynthia Enzlberger-Vaughan (Austria)
Elisabeth Kawczynski (Canada)

Publications[1]

Journal Articles

Ermoliev Y, Ermolieva T, Fischer G & Makowski M (2009). Extreme events, discounting and stochastic optimization. *Annals of Operations Research*, Article in press (Published online 17 September 2009). [IME]*

Fischer G, Ermolieva T, Ermoliev Y & Sun L (2009). Risk-adjusted approaches for planning sustainable agricultural development. *Stochastic Environmental Research and Risk Assessment*, 23(4):441-450 (May 2009). [IME]*

Li T, Sun L & Zou L (2009). State ownership and corporate performance: A quantile regression analysis of Chinese listed companies. *China Economic Review*, 20(4):703-716 (December 2009).*

Ogryczak W & Kozlowski B (2009). Reference point method with importance weighted ordered partial achievements. *TOP*, Article in press (Published online 02 November 2009).*

Pesque-Cela V, Tao R, Liu Y & Sun L (2009). Challenging, complementing or assuming "the Mandate of Heaven"? Political distrust and the rise of self-governing social organizations in rural China. *Journal of Comparative Economics*, 37(1):151-168 (March 2009).*

Teixeira E, Moot DJ & Brown HE (2009). Modelling seasonality of dry matter partitioning and root maintenance respiration in lucerne (*Medicago sativa* L.) crops. *Crop and Pasture Science*, 60(8):778-784 (5 August 2009).*

Book Chapters

Ermolieva T, Ermoliev Y, Fischer G & Makowski M (2009). 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, pp. 45-68. [IME]*

Ermolieva T, Makowski M, Fischer G & Ermoliev Y (2009). Economic evaluation of dams for flood protection: An integrated safety approach. In: de Wrachien D & Mambretti S (eds), *Dam-break Problems, Solutions and Case Studies*. WIT Press, Southampton, UK, pp. 241-272. [IME]*

Research Reports

Compton KL, Faber R, Ermolieva TY, Linnerooth-Bayer J & Nachtnebel H-P (2009). Uncertainty and Disaster Risk Management: Modeling the Flash Flood Risk to Vienna and Its Subway System. IIASA Research Report RR-09-002. [RAV]*

Other Publications

Ermoliev Y, Ermolieva T & Makowski M (2009). Effective coping with uncertainties in evaluation of the compliance to international treaties (Abstract). In: *ISS09 Book of Abstracts*, International Scientific Studies Conference, 10-12 June 2009, Hofburg, Vienna, Austria, p. 133. [IME, GGI]

Ermolieva T, Ermoliev Y, Fischer G, Jonas M, Makowski M & Wagner F (2009). Carbon emissions trading and carbon taxes under uncertainties (Abstract). In: *CwU'2009: IIASA/GAMM Workshop on Coping with Uncertainty: Managing Safety of Heterogeneous Systems – Abstracts*, 14-16 December 2009, IIASA, Laxenburg, Austria, p. 9. [APD, FOR, IME]

1 *) Peer Reviewed
Highlighted publications appear more than once in the IIASA Publications List:
Dark brown entries: IIASA author collaborated with IIASA colleagues from different IIASA programs, identified in brackets.

Fischer G, Hitzsnyik E, Prieler S, Shah M & van Velthuizen H (2009). Biofuels and Food Security: Implications of an Accelerated Biofuels Production. Summary of Final Report to Sponsor: OFID Pamphlet Series 38, The OPEC Fund for International Development (OFID), Vienna, Austria (March 2009).

Fischer G, Hitzsnyik E, Prieler S, Shah M & van Velthuizen H (2009). Biofuels and Food Security. Final Report to Sponsor: The OPEC Fund for International Development (OFID), Vienna, Austria (March 2009).

Fischer G, van Velthuizen H, Hizsnyik E & Wiberg D (2009). Potentially obtainable yields in the semi-arid tropics. Global Theme on Agroecosystems, Report no. 54. International Crops Research Institute for the Semi-Arid Tropics, Andhra Pradesh, India.

Fischer G, van Velthuizen H & Shah M (2009). Biofuels climate change: Challenges to food security in the 21st century. *Options* (IIASA, Laxenburg, Austria), Winter 2009/2010, pp. 18-19.

Fischer G, van Velthuizen H & Shah M (2009). Poverty and food insecurity: A threat to billions. *Options* (IIASA, Laxenburg, Austria), Summer 2009, pp. 14-17.

Hurtt GC, Chini LP, Frolking S, Betts R, Fischer G, Kindermann G, Kinoshita T, Riahi K, Shevliakova E, Smith S, van Vuuren DP, Wang YP, et al. (2009). Harmonisation of global land-use scenarios for the period 1500-2100 for IPCC-AR5. *iLEAPS Newsletter* (University of Helsinki, Finland), 7:6-8 (June 2009). [ENE, FOR, TNT]

Nachtergaele F, van Velthuizen H & Verelst L (2009). Harmonized World Soil Database. FAO, Rome, Italy, and IIASA, Laxenburg, Austria (March 2009).

Shah M, Fischer G & van Velthuizen H (2009). Food Security and Sustainable Agriculture: The Challenges of Climate Change in Sub-Saharan Africa. In: Climate Change and Economic Development in Sub-Saharan Africa -- AERC Senior Policy Seminar X, Addis Ababa, Ethiopia, 7-9 April 2008: Seminar Papers, African Economic Research Consortium, Nairobi, Kenya.*

Teixeira E (2009). Food crops and heat stress. *Options* (IIASA, Laxenburg, Austria), Winter 2009/2010, p. 8.

Teixeira E, Fischer G, van Velthuizen HT, Ewert F, van Dingenen R, Dentener F & Mills G (2009). Surface ozone impact on global food supply: Potential damage and adaptation for soybean crops (Abstract). *IOP Conference Series: Earth and Environmental Science*, 6(37):372043 (1 February 2009).*

Conference Proceedings

Fischer G (2009). World food and agriculture to 2030/50: How do climate change and bioenergy alter the long-term outlook for food, agriculture and resource availability? In: Proceedings of the Expert Meeting on How to Feed the World in 2050. 24-26 June 2009, FAO Headquarters, Rome, Italy.

Liu S, Han L, Ermoliev Y & Ermolieva T (2009). Catastrophe bond pricing based on behavior model. In: Ma H & Narayanan S (eds), *Proceedings of the IASTED International Conference on Modelling, Simulation, and Identification*. MSI 2009, 12-14 October 2009, Beijing, China. [IME, GGI]*

Interim Reports

Ermolieva T, Winiwarter W, Fischer G, Cao G-Y, Klimont Z, Schoepp W, Li Y & Asman WAH (2009). Integrated Nitrogen Management in China. IIASA Interim Report IR-09-005. [APD, FOR, GGI]

Reprints

Fischer G, Teixeira E, Tothne Hizsnyik E & van Velthuizen HT (2009). Land Use Dynamics and Sugarcane Production. IIASA Reprint RP-09-001, from *Sugarcane Ethanol: Contributions to Climate Change Mitigation and the Environment*, P. Zuurbier, J. van de Vooren (eds), Wageningen Academic Publishers, Netherlands, pp. 29-62 (2009).*

Scientific Recognition

Presentations:

- Ermolieva T, "Carbon emissions trading and carbon taxes under uncertainties", CwU'2009: IIASA/GAMM Workshop on Coping with Uncertainty: Managing Safety of Heterogeneous Systems, 14–16 December 2009, IIASA, Laxenburg, Austria.
- Ermolieva T, "Effective coping with uncertainties in evaluation of the compliance to international treaties", International Scientific Studies Conference, 10–12 June 2009, Hofburg, Vienna, Austria.
- Fischer G, "How do climate change and bio-energy alter the long-term outlook for food, agriculture and resource availability?". Expert Meeting "How to Feed the World in 2050?", 24–26 June 2009, FAO, Rome, Italy.
- Fischer G, "Impacts of bio-fuel expansion on food system indicators and land use", Workshop on Marginal Yields and Land Allocation in iLUC Emission Estimates, 22 July 2009, Brussels, Belgium.

- Fischer G, "Environmental Risks and Impacts of China's Agriculture", The 27th International Conference of Agricultural Economists "The New Landscape of Global Agriculture", Beijing, August 16–22, 2009.
- Fischer G, Ermolieva T, Winiwarter W, Cao G-Y, Klimont Z, and Wagner F (2009). "Integrated Modeling Framework for Assessment and Mitigation of Agricultural Pollution: The Case of China", IIASA CSM'2009, 22nd Workshop on Methodologies and Tools for Complex System Modeling, 31 August – 2 September 2009, IIASA, Laxenburg, Austria.
- Fischer G, "FAO/IIASA Global Agro-ecological Zones – The 2009 Update", Consultancy on Climate, Land-use, Energy and Water Strategies Tool (CLEWS), 4–6 November 2009, Vienna International Center, Vienna, Austria.
- Fischer G and Prieler S, "Impacts of bio-fuel expansion on food system indicators and land use", ELOBIO 3rd Stakeholder Workshop, 17 November 2009, Brussels, Belgium.
- Fischer G, "Decision Support for the Analysis of Food Security under Uncertainties", CwU'2009: IIASA/GAMM Workshop on Coping with Uncertainty: Managing Safety of Heterogeneous Systems, 14-16 December 2009, IIASA, Laxenburg, Austria.
- Prieler S, Second generation biofuel feedstock assessment: Land use management and availability, EU-Southeast Asia Expert Meeting on 2nd Generation Biofuels: Identifying Opportunities for Collaboration, 8–9 September 2009, Bangkok, Thailand and 10-11 September 2009, Hanoi, Vietnam.
- Shah M and Fischer G, "Biofuels and Food Security: Avoiding Pitfalls and Mobilizing Potentials", CSD 17 Side Event organized by IIASA, New York, 5 May 2009.
- Shah M, Fischer G, and van Velthuizen H, "The Imperative for a Transition to Sustainable Agriculture. A spatial agro-ecological, economic and climate change global assessment: From Agenda to Policy Actions : Food Security, Feed and Biofuels", World Bank, Washington DC, 23 July 2009.
- Shah M, Fischer G, and van Velthuizen H, "Biofuels and Food Security: Lessons from a Spatial Agro-ecological, Economic and Climate Change Global Assessment", 23 July 2009, Worldwatch Institute, Washington DC, USA.
- Shah M, " The 21st Century World Imperative - From Agendas to Policies to Actions" , Green Week Brussels 23–26 June 2009, Climate change: act and adapt, Session: Working with Nature, European Commission, Brussels, Belgium, 25 June 2009.
- Shah M and Fischer G, "The Imperative for a Transition to Sustainable Agriculture Climate Change: Land, Water, Biodiversity – Food, Feed and Energy Security, From Agenda to Policy Actions to Implementation", CSD 17 Side Event on "Providing Climate, Land-use, Energy and Water Strategies" organized by International Atomic Energy Agency, New York, 11 May 2009.
- Shah M, Fischer G, and van Velthuizen H, "Food Security – Implications of an Accelerated Biofuels Production", Special OFID Session at OPEC International Seminar, 18 March 2009, Hofburg Palace Vienna, Austria.
- Wiberg D, Watch, Work Block 2: Past, Present and Future (PPF) Population, Land, and Water Use. Annual General Assembly Meeting for EU FP6 Integrated Project entitled Water and Global Change (WATCH), November 2009, Potsdam, Germany.

External Research Contracts above €10,000

Title	Funder	Date From	Date To	Total (€)	2009 (€)
SCENES Water Scenarios for Europe and for Neighbouring States	European Commission, DG Research via Finnish Environment Institute	01.11.2006	31.10.2010	107,238	47,971
CATSEI Chinese Agricultural Transition: Trade, Social and Environmental Impacts	European Commission, DG Research via Stichting Onderzoek Wereldvoedsel-voorziening van de Vrije Universiteit	01.01.2007	30.06.2010	127,780	32,100
WATCH Water and Global Change	European Commission, DG Research via Natural Environment Research Council	01.02.2007	31.01.2011	470,999	122,125
ELOBIO Effective and low-disturbing biofuel policies	European Commission, Intelligent Energy Executive Agency via Energy Research Centre of the Netherlands	01.11.2007	30.04.2010	98,967	62,603
SCENES Supplementary Funding	Federal Ministry for Science and Research (BMWF)	01.01.2008	01.04.2011	53,619	23,985
IN-STREAM INtegrating MainSTREAM Economic Indicators with those of Sustainable Development	European Commission, DG Research via Ecologic GmbH	01.08.2008	31.07.2011	146,323	55,832
Review and publish latest GAEZ results: website, viewer, development, systems documentation	Food and Agriculture Organization of the United Nations (FAO)	01.04.2009	28.02.2010	57,998	35,166
Support toward producing a thematic report on the scarcity and abundance of land and water resources for the FAO State of Land and Water (SOLAW) publication	Food and Agriculture Organization of the United Nations	01.12.2009	31.03.2010	19,503	3,646

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 on a voluntary basis by the PIN Steering Committee Group members, who collaborate with researchers and policymakers from its network, bringing IIASA a quantity (and quality) of activity that could otherwise be financially and logistically out of reach. PIN provides bridges to promoting awareness of IIASA to the broader policy community.

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 main goal is to offer basic systems analysis of the state-of-the-art of negotiation knowledge as a decision-making instrument, 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, particularly, issues of multilateral negotiation, conflict escalation and prevention, and comparative methodologies.

PIN's goals also require 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 has strengthened and rejuvenated 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. Professor Valerie Rosoux from The Catholic University at Louvain, Belgium, Professor Mikhail Troitsky from the Moscow State Institute of International Relations (MGIMO), Professor Rudolf Schüssler of the University of Bayreuth, and Ambassador Georg Stillfried from the Austrian Foreign Ministry joined the Steering Committee in 2009. Dr. Mordechai Melamud of the Comprehensive Nuclear Test Ban Organization (CTBTO) also joined the PIN Steering Committee as an Associate member in 2009.

Scientific Achievements and Policy Impact

International Conferences and Workshops

The International Negotiation Workshop on Mediating Identity Conflicts, Ottawa

On 6–7 November 2009 more than 120 professors, students and practitioners attended a two-day international negotiation workshop at Saint Paul University, Ottawa, Canada, on settling identity conflicts. The workshop was a joint collaboration of the Centre for Conflict Education and Research and the Norman Paterson School of International Affairs of Carleton University, Ottawa,the Conflict Studies Program at Saint Paul University, and IIASA's PIN Program.

PIN Summer 2009 Workshop: Negotiation on the Comprehensive Nuclear-Test-Ban Treaty (CTBT)

The PIN Program organized a workshop that took place at IIASA on 13–14 June 2009. The workshop brought to IIASA eminent practitioners with proven experience in international negotiations related to the CTBT.

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 (CTBT). The community of negotiation analysts is now participating in a new analytical endeavor, the International Scientific Negotiation Studies (SNS), the objective of which is to carry out scientific study assessments to address and evaluate the adequacy of negotiations to establish and implement the verification regime through an international coordination effort. This study is being conducted following a similar study by the Provisional Technical Secretariat (PTS) of the CTBT Organization (CTBTO) and evaluating eight different technical aspects of the CTBT. The PIN study, analyzing and evaluating the negotiation mechanisms needed by an international system and the technical studies associated with it in order to make their impact on the real/political world, represents the kind of project at which PIN excels. The PIN editing committee is Mordechai Melamud, Fen Osler Hampson, and Paul Meerts. The project will continue with another workshop at the Vienna International Center and conclude with a book publication and the development of negotiation handbook for the Inspection Team of the CTBTO. Furthermore, the PIN summer workshop in 2009 bridged the gap between practitioners and IIASA researchers, as illustrated by collaborations between CTBTO and other IIASA programs such as the Systems Analysis of the On-Site Inspection Workshop, organized by the IME, due to take place in February 2010.

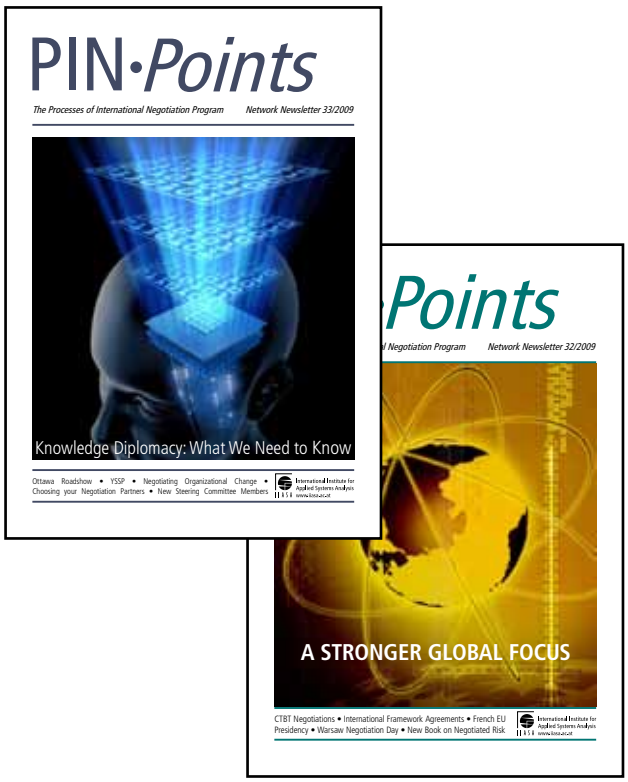
Among participants at the Summer Workshop were Pierce Corden (Center for Science, Technology and Security Policy, Ambassador Jaap Ramaker (Special Representative of Ratify-

ing States to promote ratification of the CTBT) and Dr. Hein Haak (Royal Netherlands Meteorological Institute, Ministry of Transport, Public Works and Water Management), as well as prominent researchers in the field such as Dr. Rebecca Johnsson (Acronym Institute for Disarmament Diplomacy), Prof. Nicholas Kyriakopoulus (George Washington University), and Professor P. Terrence Hopmann (John Hopkins University).

PIN 2008 Publications

PINPoints

PIN published two issues of *PINPoints* in 2009. The theme of the spring issue (#32) was a Stronger Global Focus, while that of the fall issue (#33) was Knowledge Diplomacy. *PINPoints* is currently mailed to around 4,000 members of the international negotiations community worldwide and is also available for downloading on the IIASA Web site.



Negotiated Risks—International Talks on Hazardous Issues

A new book, *Negotiated Risks—International Talks on Hazardous Issues*, edited by Rudolf Avenhaus and Gunnar Sjöstedt, was published in spring 2009 by Springer. The book fills a major gap in 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.

Publications in the Pipeline

Negotiating Climate Change (Earthscan Publications, forthcoming)

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 book is co-edited by Gunnar Sjöstedt and Ariel Macaspac Penetrante and brings together prominent policymakers and researchers in the climate change negotiations. It will be published in 2010 by Earthscan.

Unfinished Business: Saving International Negotiations from Failure (Georgia University Press, forthcoming)

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. Editors are Guy Olivier Faure and Franz Cede and the book will be published by University of Georgia Press.

Negotiating with Terrorists (Routledge Publications and USIP)

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. The project led to two books: *Terrorist Negotiations: Strategy, Tactics and Politics*, edited by Guy Olivier Faure and I. William Zartman and published in early 2010 by Routledge; and *Engaging Extremists: States and Terrorists Negotiating Ends and Means*, edited by I William Zartman and Guy Olivier Faure, to be published in 2010 by USIP, which funded part of the project.

Reducing Identity Conflicts and Preventing Genocide (Oxford University Press)

The project on "External Efforts to Facilitate Negotiations in Internal Identity Conflicts Leading to Genocide" brought together scholars and practitioners on the combined topics of mediation and conflicts over identity. It starts with the basic ideas that identity conflicts are the type that can escalate to the point of

causing genocide and that such conflicts begin with the defensive efforts of one party to protect itself out of fear of another party. The mediator therefore needs to work on both structural and attitudinal measures to halt violent escalation and fear. Following the successful workshop in 2008, PIN produced a book for publication by Oxford University Press in 2010.

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:

XII Congreso Internacional sobre Integración, Fronteras y Globalización

Helping to expand the PIN network in South America, PIN represented IIASA at the 11th International Congress on Integration, Borders and Globalization, held on 26–28 November 2009 in San Cristóbal, Venezuela. PIN presented two papers 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 Indonesia, Mexico, and the Philippines. A paper was also presented on the complexity of the climate change negotiations, particularly focusing on the North–South Divide which has to a significant extent dictated the outcome of the negotiations.

The Climate Change Negotiations Simulation at De La Salle University, Manila, Philippines

PIN organized a two-day lecture and simulation of the COP15 summit at De La Salle University in Manila, Philippines. More than 120 students and professors participated at the event which was held on 14 and 16 July 2009.

The Climate Change Negotiations Simulation during YSSP 2009

PIN organized the YSSP workshop on Climate Change on 24 June 2009, bringing IIASA staff members and YSSPers together at the negotiation table, which fostered understanding of the complexity of the climate change negotiations through practical experience.

The International Studies Association (ISA) Annual Convention

PIN organized a panel on "Negotiation with Terrorists" at the annual convention of the International Studies Association in the New York Marriot Marquis, New York City, held on 15–18 February 2009.

YSSP 2009

Goran Mihelcic (Germany) from the Department of Operations Research, University of the Federal Armed Forces in Munich, Germany, took a special look at different types of decision support systems in the context of crisis response processes (CRPs). Sinisa Vukovic (Montenegro) from the Leiden University's Institute of Political Science, Netherlands, researched mediation as a conflict management activity in international relations. Emma Paulsson (now Lund) from Lund University, Sweden, analyzed possible reforms of the Clean Development Mechanism.

Activities for 2010

Summer Workshop 2010: "Dealing with Deadlocks: Managing Negotiation Meltdowns," 18–19 June 2010, IIASA

The economic meltdown has focused attention on systems of financial regulation within and between nations, witnessed retreats from trade arrangements and pushes for protectionism in the face of rising domestic unemployment, and threatened tenuous social pacts between interest groups within countries. In some nations this has translated into open xenophobia with attacks on refugees and foreigners "stealing work." Papers with a focus on breakdowns in negotiation over economic and environmental crises, and threats to political systems (international and national) resulting from them will be presented at the 2010 workshop. The workshop intends to produce a book publication by the end of the year. The main organizers are Mark Anstey, Fen Osler Hampson, and I. William Zartman.

2nd CTBTO Training Cycle for Surrogate Inspectors, Planning Meeting for Development of Negotiation Handbook for the Inspection Team, Vienna International Center, 14–16 June 2010

As continuation of the IIASA–CTBTO collaboration, PIN is co-organizing a workshop that intends to support CTBTO in the development of a negotiation handbook for the Inspection Team.

International Studies Association (ISA) Annual Convention, New Orleans, 16–20 February 2010

PIN is organizing a panel on the CTBT negotiations at the ISA Annual Convention in New Orleans. PIN intends to present three of its current research papers from other panels at the Convention.

3rd International Workshop on Uncertainty in Greenhouse Gas Inventories, Lviv Polytechnic National University, Lviv, Ukraine, 22–24 September 2010

PIN and the Forestry Program are collaborating with the Lviv Polytechnic National University and the Systems Research Institute of the Polish Academy of Sciences in organizing the 3rd International Workshop on Uncertainty in Greenhouse Gas Inventories. PIN aims to link scientific knowledge with relevant policymakers and will organize discussion tables and simulation of the climate change negotiations.

UK Negotiation Day, University of Durham

PINs roadshow for 2010 will be held at the University of Durham, England, in collaboration with the Centre for the Study of Radicalisation and Contemporary Political Violence, Department of International Politics, University of Aberystwyth, Wales,

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, CTBTO, UN Secretariat). All work of the Steering Committee is voluntary and unremunerated.

Policy Impact in 2009

PIN published the IIASA Policy Brief, Negotiating with Terrorists: A Mediator's Guide (#06-March 2009) which outlines the practicalities of negotiations, providing a guide to deciding how, when, and with whom to negotiate, without necessarily advocating negotiating with terrorists.

The PIN coordinator met with the Philippines' Undersecretary of the Department of Foreign Affairs who is also acting as chief negotiator of the Government Negotiating Panel with the Moro Islamic Liberation Front (MILF). The PIN coordinator advised the chief negotiator on how to expand zones of possible agreement as a strategy to break the deadlock in the peace negotiations, as well as how to enhance civic society in its reconciliation efforts at the grass-roots level. The consultation was requested by the Philippine Permanent Representative to the United Nations in Vienna and took place at the Department of Foreign Affairs in Manila, Philippines, in May 2009.

Personnel Resources

Scientific Staff

Rudolf Avenhaus (Germany)
Franz Cede (Austria)
Guy Olivier Faure (France)
Victor Kremenyuk (Russia)
Paul Meerts (Netherlands)
Ariel Penetrante (Germany)
Gunnar Sjöstedt (Sweden)
William Zartmann (USA)

YSSP

Goran Mihelcic (Germany)
Emma Paulsson (Sweden)
Sinisa Vukovic (Montenegro)

Publications[1]

Book Chapters

Avenhaus R & Sjoestedt G (2009). Conclusions. In: Avenhaus R & Sjoestedt G (eds), *Negotiated Risks: International Talks on Hazardous Issues*. Springer-Verlag, Heidelberg, Germany, pp. 333-355.*

Faure GO (2009). Negotiating risks across cultures: Joint ventures in China. In: Avenhaus R & Sjoestedt G (eds), *Negotiated Risks: International Talks on Hazardous Issues*. Springer-Verlag, Heidelberg, Germany, pp. 307-331.*

Kremenyuk V (2009). Negotiations on national security risks: The case of U.S.-Soviet Relations. In: Avenhaus R & Sjoestedt G (eds), *Negotiated Risks: International Talks on Hazardous Issues*. Springer-Verlag, Heidelberg, Germany, pp. 161-180.*

Sjoestedt G (2009). Negotiating climate change: The search for joint risk management. In: Avenhaus R & Sjoestedt G (eds), *Negotiated Risks: International Talks on Hazardous Issues*. Springer-Verlag, Heidelberg, Germany, pp. 229-257.*

Sjoestedt G & Avenhaus R (2009). Introduction. In: Avenhaus R & Sjoestedt G (eds), *Negotiated Risks: International Talks on Hazardous Issues*. Springer-Verlag, Heidelberg, Germany, pp. 1-24.*

Zartman IW (2009). Risk and preventive negotiations. In: Avenhaus R & Sjoestedt G (eds), *Negotiated Risks: International Talks on Hazardous Issues*. Springer-Verlag, Heidelberg, Germany, pp. 111-128.*

Books

Avenhaus R & Sjoestedt G (eds) (2009). *Negotiated Risks: International Talks on Hazardous Issues*. Springer-Verlag, Heidelberg, Germany.*

Other Publications

Aleksy-Szucsich A (ed.) (2009). The Art of International Negotiations. Zurawia Papers Volume 14, Institute of International Relations, University of Warsaw, Poland.

Faure GO & Zartman IW (2009). Negotiating with Terrorists: A Mediator's Guide. IIASA Policy Brief #06 (March 2009).

1 *) Peer Reviewed

Interim Reports

van Schaik L (2009). The European Union, A Healthy Negotiator? A Study on its Unity in External Representation and Performance in the World Health Organization. IIASA Interim Report IR-09-015.

Scientific Recognition

- Ambassador Franz Cede received the Austrian decoration "Grand Gold Award for meritorious services rendered to the Republic of Austria."
- Ariel Macaspac Penetrante was invited to lecture at the De La Salle University, Manila, Philippines.
- Dr I William Zartman gave an invited lecture at the Truman Center of Hebrew University in Jerusalem on "Alternative Approaches to Negotiation Analysis," to Tel Aviv University on "New Theoretical Insights in Explaining Cooperation," and to the Graduate Center at Herzliya on "Ripeness in Conflict and Negotiation." He authored a Policy Paper on *The Maghreb Matters* for consideration by the U.S. Congress and Department of State, presented in a public session at the U S National Press Club, and gave a talk at the Institut Français de Relations Internationales on "US–North African Relations" and at Yale University on "U.S. Interest in Maghrebi Cooperation." He presented a paper on "Atlantic Values" to an international conference organized by the High Commissioner of the Plan in Morocco. He received the Founder's Award from the American Institute of Maghreb Studies.

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 2009

In 2009, the last year of the Program, we focused largely on completing work in each of our three areas of focus.

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 could affect aspects of wellbeing such as access to affordable energy sources in developing countries.

In 2009 we completed a global analysis of demographic effects on emissions and submitted the results to a scientific journal. The analysis brought together country case studies carried out in previous years into a unified framework, using a nine-region global version of the Population–Environment–Technology or PET model, a computable general equilibrium model with detail in the energy sector. Results show that plausible differences in population size can significantly affect future greenhouse gas emissions at the global level; in addition we found that other demographic changes such as aging and urbanization can substantially affect projected emissions in particular world regions.

We also completed three Interim Reports that document various aspects of the data, and population projections produced, that are used as input to the model. Consumption data analysis documented in one of those reports involved characterizing the economic and energy use behavior of different types of households using nationally representative household expenditure surveys for several countries including Brazil, China, India, Japan, Mexico, Russia, and the United States. 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. Population projections involved producing consistent scenarios of population size change, aging, urbanization, and the distribution of population by household type.

In addition, we finalized work carried out over the past two years 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 resulted in the publication of one Interim Report, and a manuscript in preparation that will be submitted in 2010 to the *Journal of Economic Dynamics and Control*. Results indicate that, given the empirical

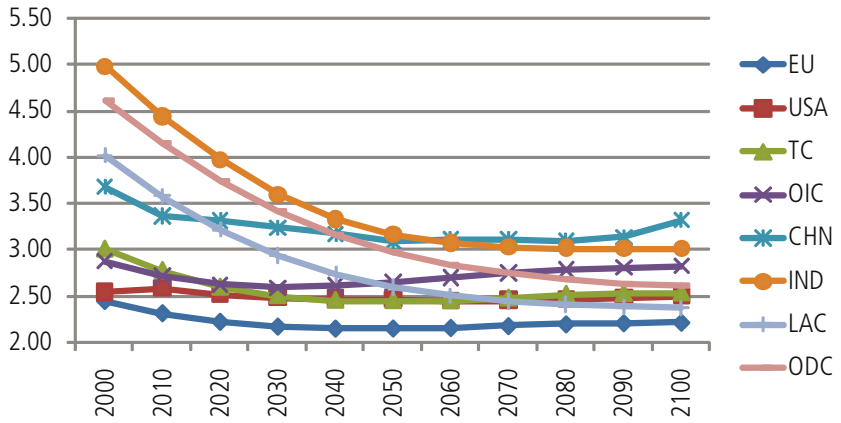


Figure 1. Changes in average household size under the medium population scenario.

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 is usually sufficient.

Finally, we completed a beta version of a user interface for the PET model that provides a simple means of using the model via a Web browser. This interface will now undergo further development at the U.S. National Center for Atmospheric Research, where it will play an important role in making the PET model widely available to the community.

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 emissions reductions until we learn more about possible climate change impacts. Others argue that we should make larger, precautionary reductions now, because waiting would risk committing the world to climate impacts that we might later learn will be more severe than anticipated. Research has not yet provided definitive answers to this question.

In 2009 we completed and published (in *Geophysical Research Letters*) a study begun in 2008 on uncertainty in climate sensitivity, a key climate system parameter with large implications for the emission reductions necessary to achieve any particular climate change goal. The paper concludes that current estimates of the uncertainty in climate sensitivity may, in fact, be underestimates because insufficient account has been taken of the uncertainty in some forcing factors, particularly that due to sulfate aerosols. In addition, we largely completed an analysis of how learning about climate sensitivity may proceed over time, drawing on extensive historical data on emissions, concentrations, and global average temperatures. We plan to finalize the manuscript and submit to a journal in 2010.

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 (FCCC) 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 FCCC. 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 2009 we completed a collaborative project with the Energy (ENE) Program that used the MESSAGE model framework to analyze mid-century emissions reduction targets and their implications for longer-term climate change goals, such as the EU 2°C target. This analysis brought together ideas and preliminary

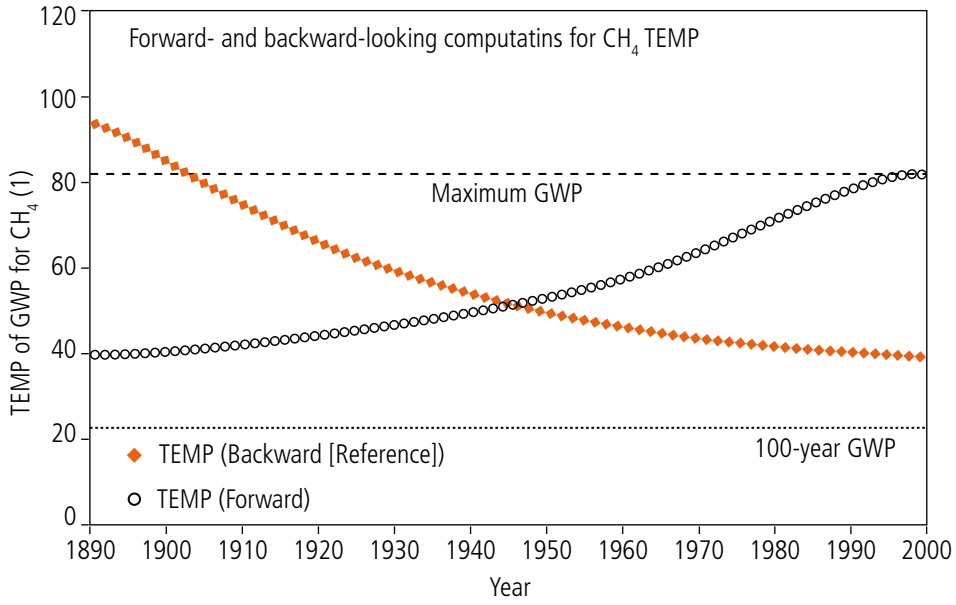


Figure 2. Calculation of a new metric for greenhouse gas emissions (called the TEMP) that could be an alternative to the commonly used GWP. The figure illustrates the case of methane. In the backward-looking calculations, TEMPs are optimized with respect to their fits to the baseline temperature between the year 1890 and the end year shifting from 1900 to 2000. In the forward-looking calculations, TEMPs are optimized between starting years ranging from 1890 to 2000 and the year 2000. The backward-looking calculation results serve as a reference for the rest of our analysis

analyses developed over the past few years into a comprehensive mitigation study of links between short-term actions and longer-term goals. Results were presented at the Copenhagen Scientific Congress in March 2009 and at a side event organized by the National Center for Atmospheric Research at COP15 in Copenhagen in December. The paper was published in *Proceedings of the National Academy of Sciences – USA* in early January, 2010, and received substantial media attention, including a story in *Nature* News.

Activities for 2010

While 2009 marked the official end of the PCC program, we plan to continue collaborative research activities between that National Center for Atmospheric Research and both the ENE and World Population (POP) programs to investigate two topics that are natural extensions of our work over the past five years.

Research in collaboration with the POP Program

- **The implications of improved education and future changes in literacy on energy use and emissions**. Changes in the future education composition of regional populations will affect both fertility rates (and therefore population size and age structure outcomes), as well as economic growth. Both effects will have implications, potentially offsetting, for energy use and emissions. We will use the PET model to evaluate the relative strength of these effects. The GTAP data we use to calibrate the PET model distinguish between skilled and unskilled labor inputs. We will relate these definitions to educational attainment, and possibly further disaggregate into additional labor categories. We will then use the POP Program's education projections to assess the impact of changes in education levels on labor productivity and outlays across the skilled and unskilled categories, and the consequent implications of these changes for future energy use and emissions. This will also add an important dimension of wellbeing to the PET scenarios.

Research in collaboration with the ENE/GEA Program

- **The impacts of household energy transitions on diminishing energy poverty and policies for improving energy access in different regions**. Lack of access to modern fuels, technologies, and electricity has important implications for the health and wellbeing of populations in many developing countries. Work on this theme will assess how energy access and transitions can be accelerated and the implications of those transitions for energy poverty. Research in 2010 will develop along a dual track involving new developments within both the PET and MESSAGE model frameworks. Both models provide complementary approaches, with the PET model addressing economic feedbacks between the energy sector and other economic sectors, between demand for energy services and supply, and between demands for different goods, and with the MESSAGE model providing greater technical differentiation, details on energy service demands, and determinants of energy technology choices.
  - The current version of the PET model focuses on aggregate outcomes in terms of energy use and emissions. However, its disaggregated household and consumption good structure allows various aspects of wellbeing across household types to be incorporated. The implications of future energy transitions for changes in the extent of energy poverty in developing countries will be assessed by disaggregating the PET model to include both a more detailed breakdown of sectors on the production side and a larger set of consumption goods, particularly energy categories. This will allow the implications of alternative energy scenarios to be analyzed for energy poverty in various regions of the world. We will also map the implications of urbanization and changes in educational compositions for income distributions in different regions, which link more directly with shifts in the use of alternative energy types.
  - Modifications and developments to the MESSAGE model will incorporate heterogeneity in the types and amounts of energy demanded by households of different income classes residing in rural and urban areas; this will allow it to assess the economic costs, energy, and greenhouse gas emission implications of alternative future pathways and policies for providing access to modern fuels and electricity to households that are currently lacking it. We will focus on analyzing the determinant of energy choices and demands and the investment requirements for expanding the supply infrastructure to meet the demands arising from access and consumption changes resulting in rising incomes and urbanization.

Personnel Resources

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)

Publications[1]

Journal Articles

Krey V, Canadell JG, Nakicenovic N, Abe Y, Andruleit H, Archer D, Grubler A, Hamilton NTM, Johnson A, Kostov V, Lamarque J-F, Langhorne N, Nisbet EG, O'Neill BC, Riahi K, Riedel M, Wang W & Yakushev V (2009). Gas hydrates: Entrance to a methane age or climate threat? *Environmental Research Letters*, 4(3):034007 (7 September 2009). [ENE, GGI, TNT]*

Tanaka K, O'Neill BC, Rokityanskiy D, Obersteiner M & Tol RSJ (2009). Evaluating global warming potentials with historical temperature. *Climatic Change*, 96(4):443-466 (October 2009). [FOR, GGI]*

Tanaka K, Raddatz T, O'Neill BC & Reick CH (2009). Insufficient forcing uncertainty underestimates the risk of high climate sensitivity. *Geophysical Research Letters*, 36:L16709 (28 August 2009).*

Book Chapters

O'Neill BC (2009). Climate change and population growth. In: Mazur L (ed.), *A Pivotal Moment: Population, Justice, and the Environment*. Island Press, Washington, DC, USA, pp. 81-94.

Spreng D & Pachauri S (2009). Changes in energy consumption in India with special emphasis on the use of non-commercial energy. In: von Rohr R, Walde P & Batlogg B (eds), *Energie*. vdf Hochschulverlag AG an der ETH Zurich, Switzerland, pp. 75-86 [in German].*

Other Publications

Grubler A & Pachauri S (2009). Problems with burden-sharing proposal among one billion high emitters (Letter). *PNAS*, 106(43):E122-E123 (27 October 2009). [GGI, TNT]*

O'Neill BC, Riahi K & Keppo I (2009). Mitigation implications of mid-century targets that preserve long-term climate policy options (Abstract). *IOP Conference Series: Earth and Environmental Science*, 6(50):502001 (1 February 2009). [ENE, GGI, TNT]*

Riahi K & O'Neill B (2009). Keeping options open. *Options* (IIASA, Laxenburg, Austria), Summer 2009, pp. 18-19. [ENE]

Tanaka K & O'Neill BC (2009). How do we learn about climate sensitivity in the future? (Abstract). *IOP Conference Series: Earth and Environmental Science*, 6(7):072065 (1 February 2009).*

Interim Reports

Fuchs R, Pachauri S & O'Neill BC (2009). Production Data for the Population–Environment–Technology (PET) Model. IIASA Interim Report IR-09-025.

Jiang L & O'Neill BC (2009). Household Projections for Rural and Urban Areas of Major Regions of the World. IIASA Interim Report IR-09-026.

Melnikov NB, O'Neill BC & Dalton MG (2009). Accounting for Household Heterogeneity in General Equilibrium Models. IIASA Interim Report IR-09-051.

Zigova K, Fuchs R, Jiang L, O'Neill BC & Pachauri S (2009). Household Survey Data Used in Calibrating the Population–Environment–Technology Model. IIASA Interim Report IR-09-046.

Reprints

O'Neill BC & Nakicenovic N (2009). Learning from global emissions scenarios. IIASA Reprint RP-09-002, from *Environmental Research Letters*, 3(2008):045014 (9pp). [ENE, TNT]*

1 *) Peer Reviewed
Highlighted publications appear more than once in the IIASA Publications List:
Dark brown entries: IIASA author collaborated with IIASA colleagues from different IIASA programs, identified in brackets.

Scientific Recognition

Selected Editorships

Brian O'Neill

- Editorial Board, *Environmental Research Letters*.
- International Editorial Board, *Global Environmental Change*.
- Associate Editor, *Population and Environment*.

Executive Editor, Integrated Assessment Domain, *Wiley Interdisciplinary Reviews – Climate Change*.

Selected Invited lectures

Brian O'Neill

- IPCC Expert Meeting on the Science of Alternative Metrics, Oslo, Norway: *A Unifying Framework for Metrics for Aggregating the Climate Effect of Different Emissions*.
- United Nations Population Fund (UNFPA) Expert Group Meeting on Population Dynamics and Climate Change, London: *Implications of Population Dynamics and Size for Mitigation*.
- International Scientific Congress on Climate Change: Global Risks, Challenges, and Decisions, Copenhagen: *Mitigation implications of mid-century targets that preserve long-term climate policy options*.

Shonali Pachauri

- Lee Kuan Yew School of Public Policy, National University of Singapore: *Energy Security from the Perspective of Households: Access and Poverty Dimensions*.
- Scientific Forum of the International Atomic Energy Agency (IAEA), Vienna: *Demography, Migration and Energy Demand*.
- The Energy Research Centre (ERC) of the University of Cape Town (UCT), South Africa: *Barriers to Enhancing Energy Access for Households in India and China*.
- The Program on Energy and Sustainable Development (PESD), Stanford University, USA: *Household Energy Choices in Developing Countries*.

Leiwen Jiang

- Third Biannual NCAR Workshop on Climate and Health, Boulder, USA: *Socioeconomic and Demographic Modeling In Climate Change Research.*
- United Nations Population Fund (UNFPA), New York, USA: *Influences of Population Dynamics on Climate Change*.
- United Nations Foundation, Washington DC, USA: *Population and Climate Change*.

Katsumasa Tanaka

- Eidgenössische Technische Hochschule (ETH) Zürich, Switzerland: *Inverse estimation for simple climate model ACC2*.

External Research Contracts above €10,000

Title	Funder	Date From	Date To	Total (€)	2009 (€)
DUAL-CLIMATE Demography, Uncertainty and Learning in Integrated Assessment Models of Climate Change	Austrian Science Fund (FWF)	01.01.2005	31.12.2009	796,310	90,476

Risk and Vulnerability Program

Joanne Linnerooth-Bayer
bayer@iiasa.ac.at

Objectives

In its fourth 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 in 2009

Disasters and Development

Contributing to the World Bank's World Development Report 2010 "Development and Climate Change," RAV's research group on *Disasters and Development* conducted a worldwide assessment of countries' exposure and financial vulnerability to extreme weather events (*Figure 1*). The high financial vulnerability of many small economies underscores the need for financial contingency planning to increase governments' resilience against future disasters. This research has informed the submission by the Munich Climate Insurance Initiative of a proposal on insurance instruments for adaptation to the climate negotiations of the United Nations Framework Convention on Climate Change (UNFCCC).

For the project "Risk to Resilience," sponsored by the United Kingdom Department for International Development (DFID), a RAV team, in collaboration with the Institute for Social and Environmental Transition (ISET) and local partners, led the development and application of methodologies for assessing disaster risks, climate change, and the costs and benefits of reducing risks across a series of case areas in India, Nepal, and Pakistan. The cases showed that disaster risk reduction can pay big dividends in these countries, and by taking climate change into account can not only greatly improve the investment return but also change the overall strategy.

RAV staff completed work on the European Union (EU)–sponsored ADAM (Adaptation and Mitigation) Project. RAV and its partners provided the first comprehensive probabilistic maps of flood and drought risks across the EU, combining estimates of hazard, vulnerability, and exposure. Hotspots for flood risk were found especially in Eastern Europe and for drought and heat stress to agriculture in Southern Europe.

RAV co-organized the Joint IIASA/Disaster Prevention Research Institute (DPRI) annual conference on "Integrated Disaster Risk Management" in Kyoto (University of Kyoto, Beijing Normal University, and IIASA).

Decisions and Governance

In collaboration with the World Food Programme and Columbia University, RAV's *Decisions and Governance* group examined the benefits of consolidating local index-based insurance systems to operate at the national scale, and modeled the effects on covariate risk in a Monte Carlo framework. IIASA researchers also examined, as a very different issue, the task of educating farmers about how such insurance operates, and tested an innovative approach that made use of a gambling game in Ethiopia

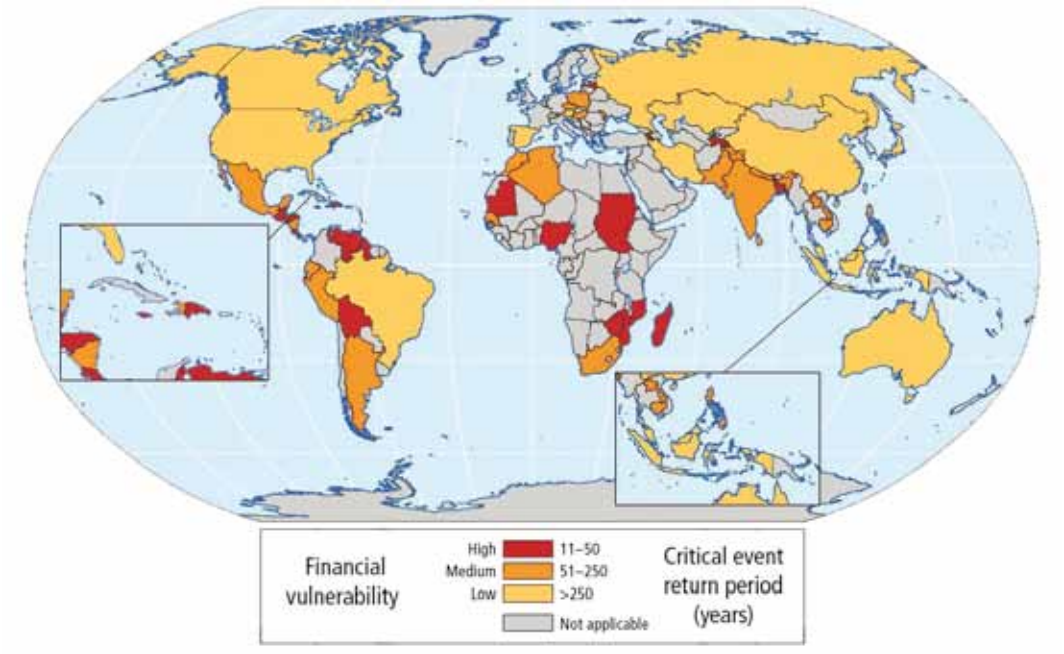


Figure 1. Map of country-level financial vulnerability to extreme weather events.

and Botswana. These projects have been published in *Global Environmental Change* and *Mitigation and Adaptation Strategies for Global Change*.

In collaboration with the Potsdam Institute for Climate Impact Research, RAV examined the risk management issues associated with the expansion of large-scale renewable energy in Europe and North Africa. The work involved stakeholder-driven empirical analysis and a modeling study. The results were widely reported in the news media, and journal papers and editorials are in press.

Finally, the *Decisions and Governance* group completed their work on the ADAM Project, which identified important overlaps between adaptation and mitigation policies, and their combined overlap with development assistance policies.

Policy Impact in 2009

Following the studies of drought and flood risk in Southeast Asian countries, a workshop with Indian policymakers was held in February in Delhi jointly organized with the Indian National Institute of Disaster Management.

Following extensive media attention to a presentation at the Copenhagen Climate Conference in March, 2009, RAV staff member, Anthony Patt, was invited to participate in a consortium to provide policy advice to the French and German governments on the Mediterranean Solar Plan, as well as presentations to business and finance stakeholders.

Joanne Linnerooth-Bayer continued collaboration with the Munich Climate Insurance Initiative with success in convincing climate negotiators to include insurance instruments in the Copenhagen negotiation text. She participated in a press conference at the Copenhagen Climate Change conference with Sir Nicholas Stern on this topic.

Activities for 2010

In 2010 RAV is starting up three new EU FP7 projects:

- MEDIATION, for which RAV will evaluate the policy context for making climate adaptation decisions in Europe as a basis for designing a decision support tool to fulfill the EC's adaptation strategy.
- RESPONSES, for which RAV will analyze policy options for climate change adaptation in the European energy, water, and agricultural sectors; and
- SAFELAND, for which RAV will design and carry out communication and participatory risk management processes for landslide risks in four European countries and India.

In addition, major activities planned by RAV's research groups include:

Disasters and Development

- Will continue to further develop a microeconomic model for assessing the risks imposed by weather-related events on rural livelihoods and poverty traps;
- Will finish an assessment of the impacts of disaster microinsurance based on surveys of six microinsurance schemes in South Asia;
- Plan to develop a socioeconomic risk module as part of the Global Earthquake Model, which will be the first fully probabilistic global earthquake risk model.
- Will co-organize the IIASA-DPRI (Kyoto University) annual meeting in Vienna.

Decisions and Governance

- Plans to continue work on renewable energy policy, with analyses of multiple types of risks in North Africa and Europe; as well as work on the economics of adaptation to climate change (World Bank);
- Will continue collaboration with the Munich Climate Insurance Initiative in support of insurance tools in the UNFCCC climate negotiations;

Water and Resilience

- Will join with Elinor Ostrom and Pieter Bots in co-editing a special issue of the journal *Ecology and Society* entitled "Governance of resource systems";
- Is editing a special edition of *Regional Environmental Change* on adapting to climate change impacts on the Tisza River basin;
- Will lead group model building exercises to understand how nutrient and carbon dynamics influence productivity in chronically flooding landscapes;
- Will participate in a collaborative project on assessing the ecological, economic, and social factors that contribute to the resilience and vulnerability of communities in West Africa.

Personnel Resources

Scientific Staff

Joanne Bayer (USA), Program Leader
Aniello Amendola (Italy)
Kerstin Damerau (Germany)
Anna Dubel (Poland)
Stefan Hochrainer (Austria)
Harvir Kalirai (United Kingdom)
Nadejda Komendantova-Amann (Austria)
Adam Krzemienowski (Poland)
Daniel Kull (USA)
Karl Lilliestam (Sweden)
Piotr Magnuszewski (Poland)
Leslie Martin (USA)
Reinhard Mechler (Germany)
Anthony Patt (USA)
Georg Pflug (Austria)
Dagmar Schröter (Germany)
Jan Sendzimir (USA)
Pablo Suarez (Argentina)
Michael Thompson (United Kingdom)
Keith Williges (USA)

Postdoctoral Research Scholars

Jason Blackstock (Canada)
Upasna Sharma (India)

YSSP

Samrat Chatterjee (India)
Wei Li (China)
Aldo Martinez Pinanez (Argentina)
Kazuyoshi Nakano (Japan)
Ikechukwu Umejesi (Nigeria)

Navarun Varma (India)

Administrative Support

Jennifer Carvill (United Kingdom)
Helene Pankl (Austria)
Jun Watabe (Japan)

Publications[1]

Risk and Vulnerability (RAV)

Journal Articles

Battaglini A, Lilliestam J, Haas A & Patt A (2009). Development of SuperSmart Grids for a more efficient utilisation of electricity from renewable sources. *Journal of Cleaner Production*, 17(10):911-918 (July 2009).*

Eakin H, Winkels A & Sendzimir J (2009). Nested vulnerability: Exploring cross-scale linkages and vulnerability teleconnections in Mexican and Vietnamese coffee systems. *Environmental Science & Policy*, 12(4):398-412 (June 2009).*

Hochrainer S, Mechler R & Pflug GC (2009). Climate change and financial adaptation in Africa: Investigating the impact of climate change on the robustness of index-based microinsurance in Malawi. *Mitigation and Adaptation Strategies for Global Change*, 14(3):231-250 (March 2009). [GGI]*

Hochrainer S & Pflug G (2009). Natural disaster risk bearing ability of governments: Consequences of kinked utility. *Journal of Natural Disaster Science*, 31(1):11-21 (January 2009).*

Komendantova N, Patt A, Barras L & Battaglini A (2009). Perception of risks in renewable energy projects: The case of concentrated solar power in North Africa. *Energy Policy*, Article in press (Published online 31 December 2009). [GGI]*

Linnerooth-Bayer J, Warner K, Bals C, Hoeppe P, Burton I, Loster T & Haas A (2009). Insurance, developing countries and climate change. *The Geneva Papers*, 34(3):381-400 (July 2009).*

Meze-Hausken E, Patt A & Fritz S (2009). Reducing climate risk for micro-insurance providers in Africa: A case study of Ethiopia. *Global Environmental Change*, 19(1):66-73 (February 2009). [FOR]*

Pahl-Wostl C, Sendzimir J & Jeffrey P (2009). Resources management in transition (Guest Editorial). *Ecology and Society*, 14(1):46 (September 2009).*

Patt A, Peterson N, Carter M, Velez M, Hess U & Suarez P (2009). Making index insurance attractive to farmers. *Mitigation and Adaptation Strategies for Global Change*, 14(8):737-753 (December 2009). [GGI]*

Pflug G (2009). Version-independence and nested distributions in multistage stochastic optimization. *SIAM Journal on Optimization*, 20(3):1406-1420 (11 November 2009). [GGI]*

Book Chapters

Patt A (2009). Communicating uncertainty to policy makers. In: Bavaye P, Mysiak J & Laba M (eds), *Uncertainties in Environmental Modelling and Consequences for Policy Making*. Springer-Verlag, Dordrecht, Netherlands, pp. 231-251.*

Patt A (2009). Learning to crawl: How to use seasonal climate forecasts to build adaptive capacity. In: Adger WN, Lorenzoni I & O'Brien KL (eds), *Adapting to Climate Change: Thresholds, Values, Governance*. Cambridge University Press, Cambridge, UK, pp. 79-95.*

Patt A, Daze A & Suarez P (2009). Gender and climate change vulnerability: What's the problem, what's the solution? In: Ruth M & Ibarraran ME (eds), *Distributional Impacts of Climate Change and Disasters: Concepts and Cases*. Edward Elgar, Cheltenham, UK, pp. 82-102.*

Research Reports

Compton KL, Faber R, Ermolieva TY, Linnerooth-Bayer J & Nachtnebel H-P (2009). Uncertainty and Disaster Risk Management: Modeling the Flash Flood Risk to Vienna and Its Subway System. IIASA Research Report RR-09-002. [LUC]*

1 *) Peer Reviewed
Highlighted publications appear more than once in the IIASA Publications List:
Dark brown entries: IIASA author collaborated with IIASA colleagues from different IIASA programs, identified in brackets.
Light brown entries: IIASA author researches for more than one IIASA program, identified in brackets.

Other Publications

Asante K, Brito R, Brundrit G, Epstein P, Nussbaumer P & Patt A et al (2009). Study on the Impact of Climate Change on Disaster Risk in Mozambique. INGC Synthesis Report on Climate Change – First Draft, National Institute for Disaster Management, Maputo, Mozambique (February, 2009).

Battisti D, Blackstock JJ, Caldeira K, Eardley DE, Katz JI, Koonin SE, Patrinos AAN, Schrag DP & Socolow RH (2009). Climate engineering responses to climate emergencies (Abstract). *IOP Conference Series: Earth and Environmental Science*, 6(45):452015 (1 February 2009). [GGI]*

Blackstock JJ (2009). Climate change: Beyond the tipping points? *Options* (IIASA, Laxenburg, Austria), Winter 2009/2010, p. 20.

Blackstock JJ, Battisti DS, Caldeira K, Eardley DM, Katz JI, Keith DW, Patrinos AAN, Schrag DP, Socolow RH & Koonin SE (2009). Climate Engineering Responses to Climate Emergencies. Novim, Santa Barbara, CA, USA (29 July 2009).

Hochrainer S (2009). Assessing the Macroeconomic Impacts of Natural Disasters: Are There Any? Policy Research Working Paper Series 4968, The World Bank, Washington, DC, USA.

Hochrainer S, Kull D, Linnerooth-Bayer J & Mechler R et al (2009). The Challenges and Importance of Investing in Cost Effective Measures for Reducing Losses From Natural Disasters in Emerging Economies. Final Report to Sponsor: The World Bank, Washington, DC, USA (2 July 2009).

Hochrainer S & Mechler R (2009). Preparing Europe for more floods and droughts. *Options* (IIASA, Laxenburg, Austria), Winter 2009/2010, p. 25.

Hochrainer S & Mechler R et al (2009). Report on Europe's financial and economic vulnerability to meteorological extremes. Deliverable D-A2.3b, ADAM (Adaptation and Mitigation Strategies: Supporting European Climate Policy).

Hochrainer S, Mechler R, Linnerooth-Bayer J & Suarez P Contributors (2009). Report on identified developing country regions for study of novel development assistance options, and characterization of risk profiles. Deliverable D-A2.6b, ADAM (Adaptation and Mitigation Strategies: Supporting European Climate Policy).

Hochrainer S, Mechler R & Pflug G (2009). Climate change and climate insurance. The case of Malawi (Abstract). *IOP Conference Series: Earth and Environmental Science*, 6(42):422003 (1 February 2009). [GGI]*

Khan F, Qutub SA, Mustafa D, Rehman A & Kull D et al (2009). Comparing urban flood mitigation options: Costs and benefits in Rawalpindi, Pakistan. In: *Catalyzing Climate and Disaster Resilience*, ISET-Nepal, Kathmandu, Nepal, pp. 133-166.

Kok K, van Vliet M, Baerlund I, Sendzimir J & Dubel A (2009). First ("first-order'') draft of pan-European European storylines – Results from the second pan-European stakeholder workshop. Deliverable 2.6, SCENES (Water Scenarios for Europe and for Neighbouring States), Wageningen University, Netherlands.

Kundzewicz ZW, Lugeri N, Hochrainer S, Moriondo M, Schelhaas M-J, Radziejewski M & Kedziora A et al (2009). Risk and economic damage assessment for 2025 and 2100, with and without adaptation. Deliverable D-A2.2b, ADAM (Adaptation and Mitigation Strategies: Supporting European Climate Policy).

Linnerooth-Bayer J (2009). Insurance in a changing climate. *Options* (IIASA, Laxenburg, Austria), Winter 2009/2010, pp. 12-13.

Linnerooth-Bayer J, Bals C & Mechler R (2009). Climate Change and Extreme Events: What Role for Insurance? IIASA Policy Brief #04 (revised December 2009).

Linnerooth-Bayer J, Bals C & Mechler R (2009). Climate insurance as part of a post-Kyoto adaptation strategy (Abstract). *IOP Conference Series: Earth and Environmental Science*, 6(42):422007 (1 February 2009).*

Linnerooth-Bayer J & Mechler R Contributors (2009). Report on strategic policy options on innovative policies for mainstreaming adaptation through pro-active disaster financing and prevention. Deliverable D-P3b.4, ADAM (Adaptation and Mitigation Strategies: Supporting European Climate Policy).

Lugeri N, Lavalle C, Hochrainer S, Bindi M & Moriondo M (2009). An assessment of weather-related risks in Europe. Deliverable D-A2.1b, ADAM (Adaptation and Mitigation Strategies: Supporting European Climate Policy).

Mechler R (2009). Disasters and Economic Welfare: Can National Savings Explain Post-disaster Changes in Consumption? Policy Research Working Paper Series 4988, The World Bank, Washington, DC, USA.

Mechler R, Hochrainer S, Kull D, Khan F, Patnaik U & Linnerooth-Bayer J (2009). Increasing resilience to extreme events. *Options* (IIASA, Laxenburg, Austria), Summer 2009, pp. 20-21.

Mechler R, Hochrainer S, Singh P, Chopde S, Wajih SA & Kull D et al (2009). Combining innovative strategies for effective drought risk management: Costs and benefits of insurance and irrigation in Uttar Pradesh, India. In: *Catalyzing Climate and Disaster Resilience*, ISET-Nepal, Kathmandu, Nepal, pp. 223-250.

Moench M, Ahmed S, Mustafa D, Khan F, Mechler R, Kull D, Dixit A & Opitz-Stapleton S et al (2009). Methods for identifying tangible strategies for risk reduction. In: *Catalyzing Climate and Disaster Resilience*, ISET-Nepal, Kathmandu, Nepal, pp. 35-69.

Moench M, Hochrainer S, Mechler R, Kull D, Linnerooth-Bayer J & Patnaik U et al (2009). Rethinking the costs and benefits of disaster risk reduction under changing climate conditions. In: *Catalyzing Climate and Disaster Resilience*, ISET-Nepal, Kathmandu, Nepal, pp. 1-34.

Nussbaumer P & Patt A (2009). Climate vulnerability in Mozambique: Current state and outlook into the future (Abstract). *IOP Conference Series: Earth and Environmental Science* 6(41):412035 (1 February 2009). [GGI]*

Patt A (2009). Expanding Solar Energy in North Africa to Achieve Climate Targets. IIASA Policy Brief #07 (December 2009).

Patt A (2009). Regional solutions for global problems. *Options* (IIASA, Laxenburg, Austria), Winter 2009/2010, p. 10.
Patt A, Battaglini A, Komendantova N, Milkoreit M & Lilliestam J (2009). Beyond feasibility: Linking the Mediterranean region's renewable energy resources to Europe – A roadmap for addressing the policy challenges (Abstract). *IOP Conference Series: Earth and Environmental Science*, 6(19):192003 (1 February 2009). [GGI]*
Sendzimir J (2009). From boom to bust: Mexico's coffee farmers. *Options* (IIASA, Laxenburg, Austria), Winter 2009/2010, p. 23.
Sendzimir J (2009). Regreening the Sahal. *Options* (IIASA, Laxenburg, Austria), Winter 2009/2010, p. 22.
Singh P, Kull D, Chopde S & Wajih SA et al (2009). Quantitative cost-benefit assessment of flood mitigation options: Uttar Pradesh, India. In: *Catalyzing Climate and Disaster Resilience*, ISET-Nepal, Kathmandu, Nepal, pp. 169-221.

Scientific Recognition

Joanne Linnerooth-Bayer and Reinhard Mechler were invited to be lead authors on the special report of the Intergovernmental Panel on Climate Change (IPCC) on "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation" (SREX).

Advisory boards

Joanne Linnerooth-Bayer: European Commission (EC) Environment Advisory Group; Board of the Austrian Climate Research Program. Invited member of Science Committee of the Chinese Academy of Disaster Reduction and Emergency Management. She was also asked to serve on a Panel Review Committee of the U.S. National Science Foundation.

Editorships

- Jan Sendzimir: Subject Editor for the online journal, *Ecology and Society.*
- Reinhard Mechler: Guest editor of special issue on "Adaptation in Europe" of *Mitigation and Adaptation Strategies for Climate Change* (with Z. Kundzewicz).
- Anthony Patt: Global Environmental Change, Editorial Board; *Regional Environmental Change*, Co-editor; Climate and Development, Co-editor.
- Joanne Linnerooth-Bayer: *Journal of Risk Research*, Associate Editor; *Risk Analysis*, Associate Editor; *Journal of Natural Resources Policy Research*, Editorial Board.
- Georg Pflug: *Computational Management Science*, Associate Editor; *Mathematical Methods of OR*, *Computational Optimizations and Application*, Associate Editor.

Selected Invited lectures

- Reinhard Mechler: Yale University's forum on "Socio-ecological resilience and disaster risk reduction: Prioritizing the gaps in a changing world," at which 2009 Economics' Nobel Laureate, Elinor Ostrom, also presented.
- Jan Sendzimir: Sustainable World Congress (Grafenegg Castle, Austria, July 2009) "Adaptive Governance for a Sustainable Future for Food and Water".

External Research Contracts above €10,000

Title	Funder	Date From	Date To	Total (€)	2009 (€)
ADAM Adaptation and Mitigation Strategies: supporting the European climate policy	European Commission, DG Research via Tyndall Centre for Climate Change Research	01.03.2006	31.07.2009	424,400	58,528
ADAM_Supplementary Funding	Federal Ministry for Education, Science and Culture (BMBWK)	01.03.2006	28.02.2009	186,004	26,178
SCENES Water Scenarios for Europe and for Neighbouring States	European Commission, DG Research via Finnish Environment Institute	01.11.2006	31.10.2010	398,988	137,084
ALICE sub Akteurshandeln und langfristige Investionsentscheidungen in Klimaschutz	Carl von Ossietzky University	01.03.2007	28.02.2010	36,603	12,736
ALICE Postdoc Research work on ALICE project; financing for postdoc	Potsdam-Institut für Klimafolgenforschung e.V. (PIK)	01.11.2007	31.10.2009	92,220	59,435
SCENES Supplementary Funding	Federal Ministry for Science and Research (BMWF)	01.01.2008	01.04.2011	191,500	65,920
Regional Risk Transfer Initiative Phase III	All India Disaster Mitigation Institute	01.08.2008	28.02.2010	25,002	15,344

Title	Funder	Date From	Date To	Total (€)	2009 (€)
Determining the Attractiveness of Alternative Risk Management Measures for Structures, Crops and Infrastructure in Hazard-Prone Areas	The World Bank	02.02.2009	29.06.2009	30,000	30,000
Answering North African questions to support policy development	European Climate Foundation	01.09.2009	31.01.2010	96,075	69,111
SafeLand Living with landslide risk in Europe: Assessment, effects of global change, and risk management strategies	European Commission, DG Research International Centre for Geohazards	01.05.2009	30.04.2012	347,981	71,587

World Population Program

Wolfgang Lutz
lutz@iiasa.ac.at

Objectives

IIASA's World Population Program (POP) works at the cutting edge of the scientific analysis of global change with respect to the quantitative aspects of human populations. It also provides science-based policy advice at the highest level to the European Commission, national governments, and UN agencies. As stated in the Research Plan 2006–2010, its main focus is on the dynamics of global population change in 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 the comprehensive analysis of the economic, social, and health returns of investments in education based on new data. It also includes analyses of societies' future adaptive capacities to climate change. To meet this ambitious goal, POP uses an extensive global network of regional population centers and function as the scientific node for these regional activities.

Scientific Achievements

The Demography of Future Global Population Aging

In 2009 POP continued its in-depth analysis of global population aging trends based primarily on its third update of probabilistic world population projections for 13 world regions. As with the two previous projections, this third assessment was also published in *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, 1996) 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. The newest projections were published in *Nature* in February 2008 ("The coming acceleration of global population ageing," Vol. 451, pp. 716–719, 2008).

In 2009 Lutz, Sanderson, and Scherbov published further results in the inaugural issue of a new scientific journal, edited by the Oxford Institute of Ageing, *Population Ageing* ("Global and regional population ageing: How certain are we of its dimensions?" 1: 75–97). Further aspects of these new projections were also published in 2009 by Lutz in *Population and Development Review* ("The demography of future global population aging: Indicators, uncertainty, and educational composition," 35(2): 357–365) as well as with specific results for China in *China Economist* ("China's grave demographic challenges in coming decades," May–June: 92–103, authors: Ren, Zheng, Lutz, and Scherbov).

New Long-term Global Population Projections to 2300

In 2009 POP finalized its extensions of the previous probabilistic population projections (which go to 2100) by defining alternative fertility and mortality scenarios for the different world regions to 2300. These projections were produced by Scherbov and Lutz and published as IIASA Interim Report IR-08-022 ("Exploratory Extension of IIASA's World Population Projections: Scenarios to 2300"). They were also presented in a prestigious invited editorial for the *Journal of the Royal Statistical Society (Series A)* ("Towards a world of 2–6 billion well-educated and therefore healthy and wealthy people," 172(4): 701–705).

Figure 1 superimposes some of these long-range scenarios on the IIASA probabilistic projections. As, in these, uncertainty ranges for fertility and mortality were defined only until 2080, the additional lines start in 2080 at different points of the distribution and keep fertility (TFR) constant at the indicated level and have life expectancy at birth increase up to the indicated maximum ("LEMAX"). We can conclude from these calculations that a world of 3–4 billion—which is sometimes stated as sustainable global population size by prominent ecologists—can be reached not only through a Malthusian "positive check" operating through increased mortality, but also in the benign way through voluntarily low fertility. If global fertility after 2080 stayed roughly constant at the level of 1.7, then the world population size would decline to 4.9–5.8 billion in 2200 (and 2.4–3.5 billion in 2300) depending on the life expectancy chosen. A fertility of 1.7 is higher than has been observed in Europe over the past decades. If we choose the current average European fertility of 1.5 as the long term level, then world population would decline to 3.5–4.4 billion in 2200 (and 1.1–1.7 billion in 2300). These exploratory scenarios teach us that a substantial long term decline in world population size is entirely feasible and could happen at the same time with significant further improvements in health and life expectancy.

Future Trends in the Prevalence of Severe Activity Limitations in Developed Countries

The year 2009 also saw some highly innovative work by Scherbov and Sanderson. It is undisputed that life expectancies at older ages continue to increase in most developed countries. But how these additional years will be divided between those with and without severe activity limitations has remained an important open question. To answer this question, the authors used data from the Survey of Income and Living Conditions (SILC). SILC provides harmonized data for 24 European countries from 2005 through 2007. The study showed that, on average, life expectancies without severe activity limitations at age 65 in high income OECD countries are likely to increase by around 2.7 years between 2005–2010 and 2045–2050. Proportions of 60+ populations with severe activity limitations are likely to be

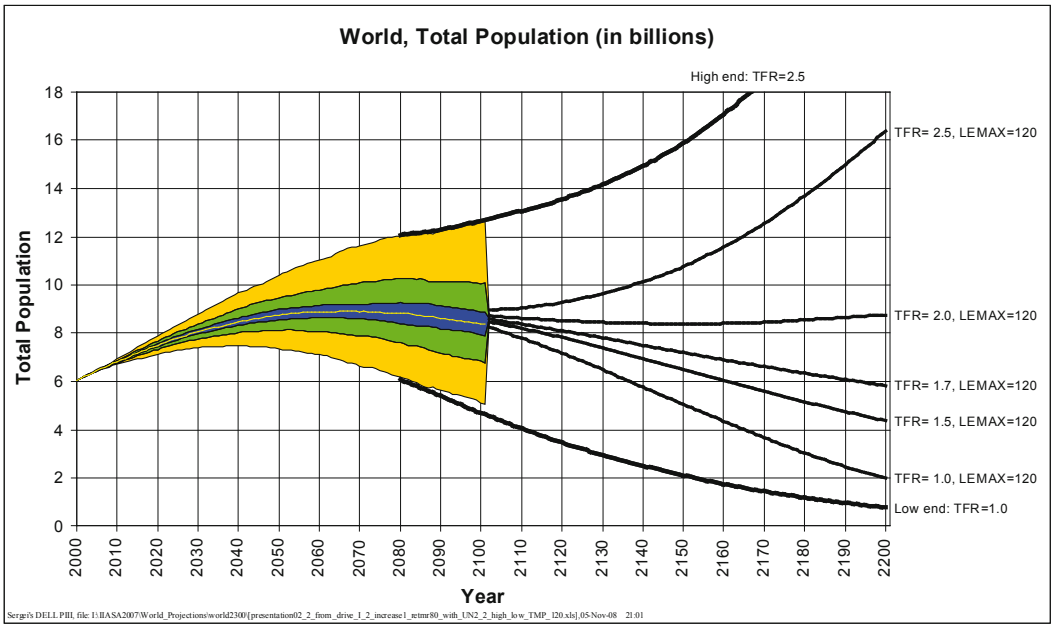


Figure 1. Total world population in billions: Probabilistic projections until 2100 (yellow [light gray] 95% interval; green [dark gray] 60%; blue [black] 20%) and extensions to 2200 (for scenario labels, see text). Source: IIASA Interim Report IR-08-022.

only marginally higher in 2045–2050 than in 2005–2010. They also showed that the speed of increase of the Genuine Adult Dependency Ratio is around one-fifth faster than the conventional old age dependency ratio. Their results were published in IIASA Interim Report IR-09-047 ("Future Trends in the Prevalence of Severe Activity Limitations in Developed Countries").

Demography, Education and Democracy: Global Trends and the Case of Iran

Another study on the returns to education using our new IIASA reconstructions of human capital by age and sex looks at the implications on quality of governance and democratic rights. Together with M.J. Abbasi-Shavazi (University of Tehran, Iran, and the Australian Demographic and Social Research Institute, Australian National University), Lutz and Crespo Cuaresma produced a paper entitled "Demography, Education and Democracy: Global Trends and the Case of Iran" which has been accepted for publication in *Population and Development Review*. The results show the consistently strong effects of improving overall levels of educational attainment, of a narrowing gender gap in education, and of fertility declines and the subsequent changes in age structure on improvements in the democracy indicator. This global relationship is then applied to the Islamic Republic of Iran which over the past two decades has experienced the world's most rapid fertility decline associated with massive increases in female education. Hence, based on the experience of 120 countries since 1970, Iran has a high chance of achieving greater democracy over the coming years.

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: The Fast Track Scenario assumes the fastest possible expansion of the education system; the Global Education Trends Scenario assumes that future improvements follow the trend of the past improvements in all countries of the world; the Constant Enrollment Rate Scenario assumes constant school enrollment rates; and the Constant Enrollment Number Scenario assumes no new schools and results 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 IIASA Interim Report IR-08-038 (Projection of Populations by Level of Educational Attainment, Age and Sex for 120 Countries for 2005–2050) and are now forthcoming in the refereed online journal *Demographic Research*. *Figure 2* shows the global level results of these new reconstructions and projections of population by age, sex, and four levels of educational attainment.

Preparations for the New Science-based IIASA-Oxford Global Population Projections

As part of the European Research Council (ERC) Advanced Investigator Grant (2.5 million Euros) won by Wolfgang Lutz for a study on "Forecasting Societies' Adaptive Capacities to Climate Change" (FutureSoc), preparations for a new set of population projections by age, sex, and level of educational attainment were initiated. These projections will be carried out by IIASA in collaboration with the James Martin School for 21st Century Studies of Oxford University. Unlike all previous population projections, where the assumptions have been defined by small groups of experts, in this major new effort many alternative arguments about possible future trends in fertility, mortality, migration, and education will be assessed by more than 1,000

experts from around the world. This scientific peer-review process will be carried out with the help of an electronic questionnaire. In 2009 a draft questionnaire was produced and several informal meetings were held at IIASA and Oxford. The general approach was developed under an EU FP7 Project MICMAC and is described in IIASA Interim Report IR-09-037 ("Toward a Systematic, Argument-Based Approach to Defining Assumptions for Population Projections").

Policy Impact in 2009

In 2009 Wolfgang Lutz published a paper in *Philosophical Transactions of the Royal Society* ("*Sola schola et sanitate:* Human capital as the root cause and priority for international development?" Series B 364: 3031-3047) based on many empirical studies and modeling exercises carried out at IIASA over the past two decades. It concludes that there is a strong case for giving absolute priority to education and health issues in all efforts of poverty eradication and global development. This is in sharp contrast to current priorities where only a tiny percentage of total ODA is spent on basic education (between 0.3 and 4.0 percent of official development assistance (ODA) in most countries of the Organisation for Economic Co-operation and Development (OECD). These new insights are currently being communicated to the international policy community in a series of speeches and events in academic as well as policy settings.

Activities for 2010

In 2010 POP will continue to pursue the research agenda as described in the Research Plan 2006–2010 and continue work on the new ERC project FutureSoc as well as initiate the work on the new ERC project ACC.

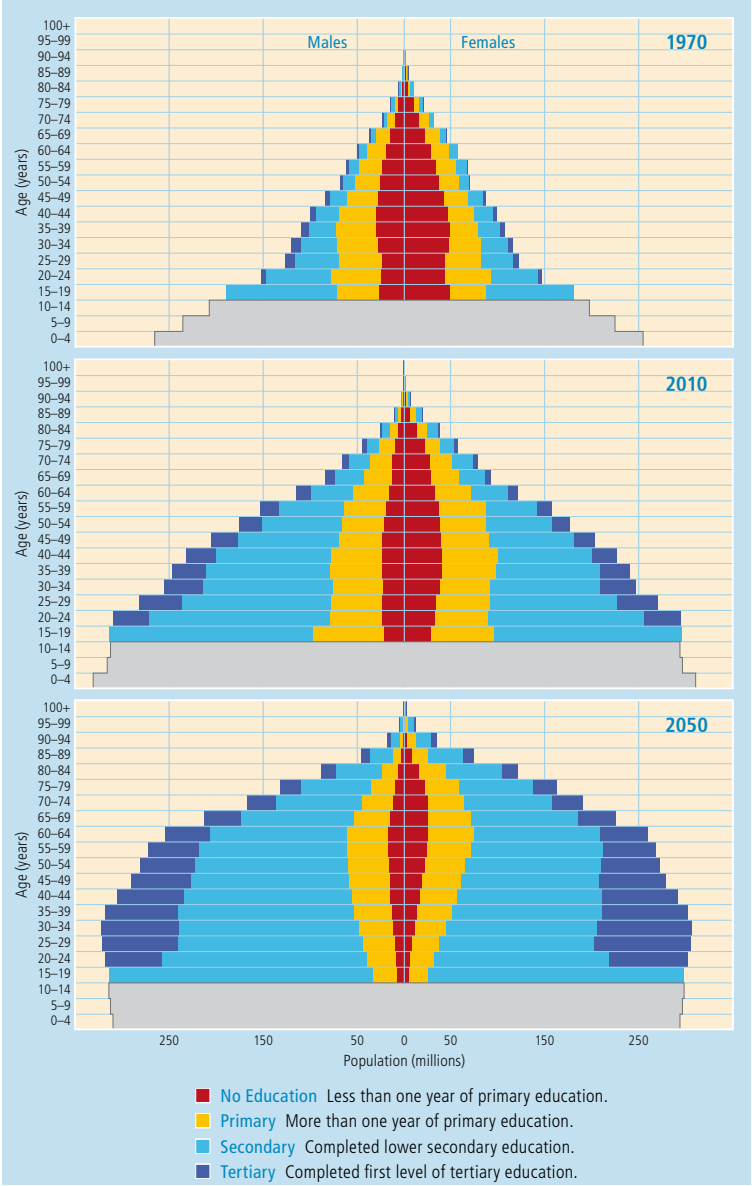


Figure 2. The world's growing human capital: World population by age, sex, and educational attainment in 1970 (top) and in Global Education Trend (GET) Scenarios for 2010 (middle) and 2050 (bottom).

Personnel Resources

Scientific Staff

Wolfgang Lutz (Austria), Program Leader
Bilal Barakat (Germany)
Stuart Basten (United Kingdom)
Jinho Choi (Republic of Korea)
Jesus Crespo Cuaresma (Spain)
Regina Fuchs (Austria)
Anne Goujon (France)
Samir K.C. (Nepal)
Harold Lentzner (USA)
Elke Loichinger (Germany)
Elsie Pamuk (USA)
Warren Sanderson (USA)
Serguei Scherbov (Netherlands)
Vegard Skirbekk (Norway)
Marcin Stonawski (Poland)
Erich Striessnig (Austria)
Muhammad Wazir (Pakistan)

Postdoctoral Research Scholar

Erling Häggström Lundevaller (Sweden)

YSSP

Zakarya Al Zalak (Syria)
Marta Jankowska (USA)
Elke Loichinger (Germany)

Administrative Support

Marilyn Brandl (Austria)
Ekaterina Smirnova (Netherlands)

Publications[1]

Journal Articles

Azomahou T, Diebolt C & Mishra T (2009). Spatial persistence of demographic shocks and economic growth. *Journal of Macroeconomics*, 31(1):98-127 (March 2009).*

Crespo Cuaresma J, Jumah A & Karbuz S (2009). Modelling and forecasting oil prices: The role of asymmetric cycles. *The Energy Journal*, 30(3):81-90 (1 July 2009).*

Crespo Cuaresma J & Slacik T (2009). On the determinants of currency crises: The role of model uncertainty. *Journal of Macroeconomics*, 31(4):621-632 (December 2009).*

Engelhardt H, Buber I, Skirbekk V & Prskawetz A (2009). Social involvement, behavioural risks and cognitive functioning among older people. *Ageing and Society*, Article in press (Published online 14 December 2009).*

Lutz W (2009). The demography of future global population aging: Indicators, uncertainty, and educational composition. *Population and Development Review*, 35(2):357-365 (June 2009).*

Lutz W (2009). *Sola schola et sanitate:* Human capital as the root cause and priority for international development? *Philosophical Transactions of the Royal Society B (Biological Sciences)*, 364:3031-3047 (27 October 2009).*

Lutz W (2009). Towards a world of 2–6 billion well-educated and therefore healthy and wealthy people (Editorial). *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 172(4):701-705 (October 2009).*

Mishra T (2009). Comment on "The uncertain unit root in real GNP: A re-examination." *ournal of Macroeconomics*, 31(1):167-172 (March 2009).*

Ren Q, Zheng X, Lutz W & Scherbov S (2009). China's grave demographic challenges in coming decades. *China Economist*, 3:92-103 (May–June 2009).*

Stoellberger C, Lutz W & Finsterer J (2009). Heat-related side-effects of neurological and non-neurological medication may increase heatwave fatalities. *European Journal of Neurology*, 16(7):879-882 (July 2009).*

Terama E (2009). Urban and peri-urban population dynamics in case study cities within Europe. *Finnish Yearbook of Population Research 2009*, XLIV:109-122.*

Book Chapters

Bjoerklund G, Connor R, Goujon A, Hellmuth M, Moriarty P, Rast W, Warner K & Winpenny J (2009). Demographic, economic and social drivers. In: Programme World Water Assessment (ed.), *Water in a Changing World: The United Nations World Water Development Report 3*. UNESCO Publishing / Earthscan, London, UK, pp. 29-40.*

Goujon A & KC Samir (2009). Past, present, and future demographic trends in Spain [Pasado, presente y futuro de las tendencias demograficas en Espana]. In: Ferrer JV (ed.), *Economia Espanola,* 2nd Edition. McGraw-Hill, Madrid, Spain, pp. 75-86 [in Spanish].*

1 *) Peer Reviewed
Highlighted publications appear more than once in the IIASA Publications List:
Dark brown entries: IIASA author collaborated with IIASA colleagues from different IIASA programs, identified in brackets.

Lutz W (2009). Changing population size and distribution as a security concern. In: Brauch HG, Spring UO, Grin J, Mesjasz C, Kameri-Mbote P, Behera NC, Chourou B & Krummenacher H (eds), *Facing Global Environmental Change*. Springer-Verlag, Heidelberg, Germany, pp. 203-213.*

Lutz W (2009). Global population ageing and the world's future human capital. In: Healey P & Rayner Steve (eds), *Unnatural Selection: The Challenges of Engineering Tomorrow's People*. Earthscan, London, UK, pp. 221-228.*

Lutz W, KC Samir, Khan HTA, Scherbov S & Leeson GW (2009). Future ageing in Southeast Asia: Demographic trends, human capital, and health status. In: Arifin EN & Ananta A (eds), *Older Persons in Southeast Asia: An Emerging Asset*. ISEAS Publishing (Institute of Southeast Asian Studies), Singapore, pp. 47-67.*

Lutz W, Sanderson WC, Scherbov S & KC Samir (2009). Demographic and human-capital trends in Eastern Europe and Sub-Saharan Africa. In: Stiftung Bertelsmann & Institute Migration Policy (eds), *Talent, Competitiveness and Migration: The Transatlantic Council on Migration*. Bertelsmann Stiftung, Guetersloh, Germany, pp. 163-192.*

Mishra T & Parhi M (2009). Age-structured human capital dynamics and economic growth: A note on interdependence, coordination and welfare. In: Rout HS & Panda PK (eds), *Human Development: Dimensions and Strategies*. New Century Publications, New Delhi, India, pp. 129-183.*

Ren Q, Zheng X, Lutz W & Scherbov S (2009). Uncertain population dynamics and HIV/AIDS in China. In: Tucker J, Poston DL, Ren Q, Gu B, Zheng X & Russell C (eds), *Gender Policy and HIV in China: Catalyzing Policy Change*. Springer-Verlag, Heidelberg, Germany, pp. 9-25.*

Research Reports

KC Samir (2009). Lung Health in Rural Nepal: Multi-State Modeling of Health Status and Economic Evaluation of Integrated Respiratory Care Guidelines. IIASA Research Report RR-09-001.*

Other Publications

Goujon A & KC Samir (2009). Women's level of educational attainment in North Africa (1970–2050). Gender gap versus gender dividend: Challenges and policy implications. In: Lutz W & Goujon A (eds), *Capital Humano, Genero y Envejecimiento en el Mediterraneo*, PAPERSIEMed. 7, IEMed., Barcelona, Spain, pp. 19-29 [in Spanish].*

Lutz W (2009). Boosting education lowers population growth. *Options* (IIASA, Laxenburg, Austria), Winter 2009/2010, p. 22.

Lutz W (2009). International migration: Threat or solution? *Options* (IIASA, Laxenburg, Austria), Summer 2009, pp. 12-13.

Lutz W & Goujon A (eds) (2009). *Human Capital, Gender and Aging in the Mediterranean. Medium- and Long-term Perspectives*. PAPERSIEMed. 7, IEMed., Barcelona, Spain [in Spanish].*

Lutz W, KC Samir & Scherbov S (2009). Future population growth, aging and human capital in the Mediterranean. In: Lutz W & Goujon A (eds), *Capital Humano, Genero y Envejecimiento en el Mediterraneo*, PAPERSIEMed. 7, IEMed., Barcelona, Spain, pp. 19-29 [in Spanish].*

Mamolo M & Scherbov S (2009). Population Projections for Forty-Four European Countries: The Ongoing Population Ageing. European Demographic Research Papers No. 2, Vienna Institute of Demography of the Austrian Academy of Sciences, Vienna, Austria.

Sobotka T & Lutz W (2009). Misleading Policy Messages from the Period TFR: Should We Stop Using It? European Demographic Research Papers No. 4, Vienna Institute of Demography of the Austrian Academy of Sciences, Vienna, Austria.

Conference Proceedings

Sanderson WC & Scherbov S (2009). Aging: A new look into an old problem. In: Mohl W (Guest ed.), *Proceedings of the International Conference on Aging*. 29-31 Ocotober 2008, Beijing, China. Supplement to *Wiener Klinische Wochenschrift*, 121(7-8):S6-S8 (May 2009).*

Interim Reports

Lutz W (2009). *Sola Schola et Sanitate:* Human Capital as the Root Cause and Priority for International Development? IIASA Interim Report IR-09-008.

Lutz W (2009). Toward a Systematic, Argument-Based Approach to Defining Assumptions for Population Projections. IIASA Interim Report IR-09-037.

Lutz W, Crespo Cuaresma J & Abbasi-Shavasi MJ (2009). Demography, Education and Democracy: Global Trends and the Case of Iran. IIASA Interim Report IR-09-019.

Sanderson WC & Scherbov S (2009). Future Trends in the Prevalence of Severe Activity Limitations in Developed Countries. IIASA Interim Report IR-09-047.

Sanderson WC & Striessnig E (2009). Demography, Education, and the Future of Total Factor Productivity Growth. IIASA Interim Report IR-09-002. [APD]

Scientific Recognition

ERC Starting Grant

Vegard Skirbekk was awarded the highly competitive Starting Grant of the ERC for a project entitled "Age and Cohort Change" (ACC). The project will investigate two major topics: 1) human capital, skills, and work performance; and 2) beliefs and attitudes in Europe until 2050. Using demographic methods, age-specific and cohort-specific changes will be quantitatively disentangled and the results used to project future changes. The fields of application range from changes in attitudes and beliefs to skills and productivity. It is expected that, viewed together, these analyses will result in significant new insights and provide pioneering frontier research about likely social and economic developments associated with aging and demographic change in Europe and the appropriate policies for coping with them.

Skirbekk's Starting Grant is the third of the ERC personal grants (after the Advanced Grant won by Lutz in 2008 and the Starting Grant won by Brian O'Neill in 2005) received by IIASA for researchers working in POP.

Mattei Dogan Award of the IUSSP

Wolfgang Lutz was awarded the Mattei Dogan Award of the International Union for the Scientific Study of Population (IUSSP). This prestigious award is given only once every four years to a globally leading scholar in comparative demographic analysis. It was presented at the occasion of the IUSSP General Conference in Marrakech in September 2009 where Lutz gave a plenary talk on "Population and Climate Change."

Advisory Boards and Editorships

Wolfgang Lutz

Member of the Committee on Population, US National Academy of Sciences.
Member, Board of Directors, Population Reference Bureau, Washington D.C., USA.
Member, Board of Directors (Vorstand), Berlin Institute for Population and Development, Germany.
Editor, *Vienna Yearbook of Population Research*.
Associate Editor, *International Statistical Review*, the official journal of the ISI (International Statistical Institute and the Bernulli Society).
Editorial Committee Member, *Asian Population Studies*, Routledge.
Editorial Board Member, *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.
Editorial Board Member, *Canadian Studies in Population*, Population Research Laboratory, University of Alberta.

Selected Invited Lectures

POP staff were invited to give lectures and papers at many international and local scientific meetings throughout the year. Here is a selection of the most noteworthy.

Wolfgang Lutz

- Invited lecture "*Schola et Sanitate:* Human capital as the root cause and priority for development?" at the Bixby Forum on the World in 2050, Berkeley, California, USA, 22–25 January.
- Invited lecture "World population, human capital and climate change" at the Shanghai Forum 2009, 9–13 May.
- Plenary keynote speech "World population, human capital and climate change" at the 7th International Science Conference on the Human Dimensions of Global Environmental Change Open Meeting "Social Challenges of Global Change," Bonn, 26–28 April.
- Keynote speech "World population and human capabilities" at the World Resources Forum 2009, Davos, Switzerland, 14–17 September.
- Invited lecture "IIASA's human capital projections" at the Digitalized Globe 2019 Conference, Munich, 27 October.
- Invited public lecture "Demographie und Bildung: Triebfedern der zukünftigen Entwicklung in Österreich und der Welt" at the Wiener Vorlesungen in the City Hall of Vienna, 26 November.

Sergei Scherbov

- Presentation "Trends in the prevalence of severe activity limitations in developed countries" at the International Interdisciplinary Expert Conference on Prevention of Age-Related Diseases, Shanghai, PR China, 26 October–2 November.

Vegard Skirbekk

- Keynote speech "Quality of ageing and economic policy in Germany" at the Symposium on Wirtschaftspolitische Herausforderungen des demografischen Wandels, Deutsche Gesellschaft für Demographie, in cooperation with the Bundesministerium für Wirtschaft und Technologie, Berlin, 26–27 February.

- Invited lecture "Postponing Retirement" (together with Ed Lazear) for the opening session at the Conference on Rethinking Retirement in Europe, Dutch Social Economic Council, Netspar, CPB Netherlands Bureau for Economic Policy Analysis, The Hague, 23–24 April.

External Research Contracts above €10,000

Title	Funder	Date From	Date To	Total (€)	2009 (€)
MIC/MAC Bridging the micro-macro gap in population forecasting	European Commission, DG Research via Koninklijke Nederlands Akademie van Wetenschappen, Nederlands Interdiciplinair Demografisch Instituut - NIDI	01.05.2005	30.04.2009	114,920	22,728
PLUREL Peri-Urban Land Use Relationships - Strategies and Sustainability Impact Assessment Tools for Urban-Rural Linkages	European Commission, DG Research via Royal Veterinary and Agricultural University	01.01.2007	31.12.2010	228,234	26,378
FutureSoc Forecasting Societies Adaptive Capacities to Climate Change	European Commission, DG Research	01.03.2009	28.02.2014	2,438,401	288,167
ACC The demography of skills and beliefs in Europe with a focus on cohort change	European Commission, European Research Council (ERC) Executive Agency	01.10.2009	30.09.2014	981,416	36,164

Part III

Energy and Technology

Dynamic Systems Program

Arkady Kryazhimskiy
kryazhim@iiasa.ac.at

Objectives

The DYN Program has the following objectives: to develop analytic approaches to assessment and control of dynamical systems related to economics and the environment; and to apply these methods to particular systems in IIASA's applied research. DYN addresses research problems within three areas — *A: Assessment of Dynamical Systems*; *B: Economic Dynamics*; and *C: Ecological Dynamics and Environmental Management*. New application-oriented methods developed within area A create a specific "IIASA niche" in applied mathematics, with a focus on control theory, theory of dynamical systems, and theory of dynamic games. Projects performed within areas B and C link area A to IIASA's applied research; they form channels through which DYN's methods are used in-house, and conversely, important methodological issues from applied programs initiate DYN's research in area A.

Scientific Achievements in 2009

Area A: Assessment of Dynamical Systems

A1 – The optimization of infinite-horizon growth project. The project develops a new branch of mathematical optimal control theory, closely related to problems of optimization of infinite-horizon economic growth processes. Very often, well-established instruments of mathematical optimal control theory turn out not to be applicable to identifying optimal processes whose durations are infinitely long. The theory elaborated by DYN provides a an essential analytic technique. In 2009 the theory was enriched by new examples and served as a basis for several research efforts in area B.

A2 – The numerical dynamic optimization project. The study was related to project A1 and focused on numerical construction of the solutions to optimal economic growth problems. Based on a qualitative analysis of the steady states of the Hamiltonian systems associated with infinite-horizon optimal control problems, a backward simulation algorithm for the approximate construction of the optimal growth trajectories was developed. High order estimates connecting the approximation accuracy in the system's state space to that in the values of the utility index were derived to justify the reliability of the proposed backward integration procedure for the stiff differential equations describing the Hamiltonian systems. The theoretically justified numerical technique was used in area B.

A3 – The growth under random shock project. The project applied the infinite-horizon growth optimization technique (see A1) to a new model of an economy driven by a "lagging" sector (producing goods for consumption) and a "booming" sector (e.g., a natural resources sector). The model assumes that the "booming" sector survives a price shock at a random point in time. A complete analytical characterization of the optimal investment policy was provided (see *Figure 1)*. It was stated that investment in the "booming" sector dominates if the expected price shock is insignificant, its probability is low, and the inflation rate is high; in the opposite case investment in the "lagging" sector dominates; and in an intermediate case there is an optimal balance between investments in the two sectors.

A4 – The dynamic games and applications project. Based on the theory of closed-loop differential games, a method of ideal program packages was developed. The method uncovers the nature of dynamic uncertainty caused by a deficit in information available online. An emission reduction process involving several countries was analyzed as a repeated game; a boundedly rational decision-making process that brings countries to a mutually acceptable decision without an exchange of countries' individual information was suggested.

Area B: Economic Dynamics

B1 – The economic growth simulation project. The project focuses on understanding the key features of a country's optimal long-term investment policy. The infinite-horizon optimal control theory elaborated by DYN (see A1) and associated computational methods (see A2) are used to analyze an aggregated economic growth model calibrated using historical data. The resulting model-, data- and theory-based forecasts provide evidence of the need of invention of new technologies to prevent stagnation. In 2009 DYN's earlier forecasts done for the United States were complemented by forecasts for Austria, Japan, and the United Kingdom.

B2 – The market capacity development project. The project viewed the emergence of new products as a mechanism for extending the market capacity. An aggregated model describing the coupled market and production dynamics was constructed. The model assumes that investment in new production technologies increases the market capacity, and the latter guides the dynamics of the number of products. Under appropriate R&D investment scenarios, the model showed a good fit with empirical data for Japan's mobile phone market.

B3 – The development of transportation infrastructure in the context of economic growth project. This collaborative DYN-FOR project was launched in 2008 and completed in 2009. The project studied transportation infrastructure as an important driving force of economic growth in a country. A co-evolutionary model was developed, in which the country's economic growth rate was explicitly linked to the capacity of its transportation infrastructure. Based on the DYN-elaborated theory of infinite-horizon optimal control (see A1), the optimal co-evolutionary regime was described analytically. Tests for France and Finland illustrated a potential for policy recommendations.

B4 – Climate change–driven natural catastrophes and growth project. This joint GGI-DYN project was launched in 2008 and completed in 2009. An aggregated model of the world economy was analyzed. The model assumes that annual investment is distributed between production technologies and emission reduction technologies, and random natural hazards

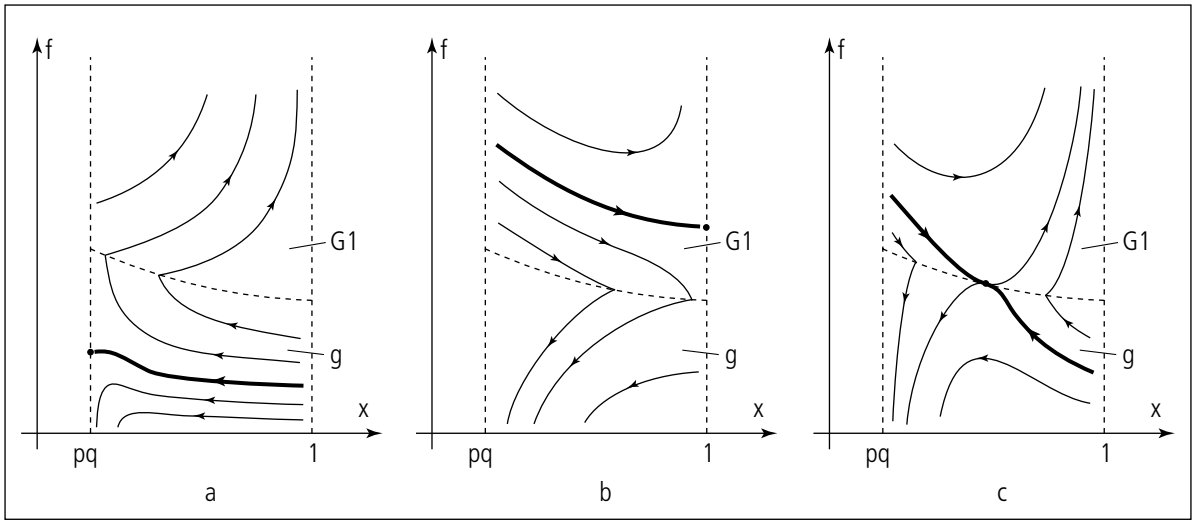


Figure 1. The result of a control-theoretic analysis of an economy driven by a "lagging" sector (producing goods for consumption) and a "booming" sector (extracting and exporting natural resources). The underlying mathematical model assumes that at a random point in time the price for the production of the "booming" sector falls down. The diagrams depict the locally optimal (extremal) trajectories in the (**x**,**f**) plane; **x** is the "GDP gap" defined as the ratio of the sizes of the economy's GDP in the cases where the price for the production of the "booming" sector is low and high, respectively; f is the shadow price. The dotted curve splits the (**x**,**f**) plane into a zone of "risky development" (zone **G1**), in which the extremal economic development implies investment in the "booming" sector only, and a zone of "cautious development" (zone g), in which the extremal economic development implies investment in the "lagging" sector only. The dotted curve itself is a zone of "balanced development", in which investment is distributed between the two sectors. The solid curves show the globally optimal trajectories selected amongst the extremal ones. Diagram (a) illustrates the case where the expected price shock is insignificant, its probability is low and the inflation rate is high; diagram (b) illustrates the opposite case; and diagram (c) shows the intermediate case. In case (a) the economy chooses the "risky development" scenario with a decreasing "GDP gap", in case (b) it chooses the "cautious development" scenario with a growing "GDP gap", and in case (c) the economy follows the "balanced development" scenario, with the "GDP gap" reaching a stationary value in a finite time.

cause non-negligible GDP losses provided that atmospheric GHG concentration exceeds a critical level. The structure obtained for the long-term utility-maximizing investment strategy shows that if the expected GDP losses are low enough, investment in the production technologies dominates; otherwise the emission reduction technologies attract major investment long before the time at which the GHG concentration crosses the critical level. An overall conclusion is that today's policy decisions strongly depend on the expected size of future GDP losses.

B5 – The political economy and endogenous technological change project. The project studied economic development in the context of policy decisions. A structure of optimal capital taxation in an economy where labor unions set wages was described, and optimal tax rules were suggested. Quotas and trade as mechanisms for the implementation of emission polices in a union of countries were comparatively analyzed. The Pareto optimal emission taxation policy was described based on an aggregated model of a union of countries with random technological change.

Area C: Ecological Dynamics and Environmental Management

C1 – The ecological network analysis project. The project includes analyses of ecological networks, based on the properties of the networks' connectedness matrices. Earlier, this approach led to the development of a new community assembly role for the operation of ecological food webs and was applied to show the importance of cycling in empirical food webs. Network analysis was also used to determine the qualitative relations (i.e., predation, competition, mutualism) between system nodes, with the discovery of the preponderance of mutualistic relations. These results encouraged the use of network mutualism as a goal function to assess and to optimize general network configurations. In 2009 this approach was extended to an illustrative analysis of natural gas pipeline flows through Eurasia and to analysis of economic input-output tables as a means of identifying flow patterns and clusters of economic sectors.

C2 – The cost and benefit analysis of Russia's participation in the Kyoto Protocol project. This project was initiated by the DYN and ECS Programs in 2003 before the Russian decision to ratify the Kyoto Protocol (KP). The project was motivated by Russia's important role in the global emission reduction process; work was completed in 2009. The aim was to provide a numerical and reproducible basis for the decision by estimating the economic consequences, costs, or benefits of Russia being bound by the limits stipulated in the KP. The Model for Evaluating Regional and Global Effects of GHG Reduction Policies (MERGE) was used in the analysis. Although the work was based on past data and no longer serves its original purpose, it clearly demonstrates the research capacity of the proposed ap-

proach and shows that the concept can be used in a post-Kyoto context.

C3 – The comparative analysis of transboundary pollution scenarios project. This project, linked to the Young Scientists Summer Program (YSSP) addressed the issue of air pollution in the European Union (EU). For the period 2015–2020, a business-as-usual pollution control scenario and a coalition pollution control scenario were analyzed using data from IIASA's GAINS model (APD) and an aggregated model linking the environmental effect from the abatement measures to their economic outcomes. The coalition scenario (based on appropriate definitions from game theory) was shown to be superior to the baseline scenario.

C4 – The management of aqua farms under ecological constraints project. Based on reaction-advection-diffusion models and ecological models of a water reservoir, it was shown that the water quality in the reservoir is strongly dependent on the distribution of the biomass of phytoplankton in the area of a farm. The optimal water-quality biomass distribution of phytoplankton was found for river aqua farms.

Policy Impact in 2009

Aseev, S. and Tarasyev, A., Research on economic growth and energy transportation, IIASA's meeting with the Russian Governmental Delegation, 7 December 2009

Activities for 2010

In 2010 DYN will combine earlier established research in areas A, B, and C with a transition to IIASA's 2011–2015 Research Plan. A goal will be to develop a background for future activities in the field of Advanced Systems Analysis (ASA). DYN will aim at contributing to ASA through three channels: the *ASA Forum*, *ASA research*, and *ASA-based applications*.

DYN's research activities in area A (Assessment of Dynamical Systems) will form a basis for DYN's contributions to the future ASA Forum and ASA research agendas. In this context, in 2010 the scope of area A will be broadened. Along with deepening analysis of infinite-horizon control processes and advancing game-theoretical studies, DYN will address new challenging questions such as:

- Is there a way to remove the gap between adaptive (myopic) and forward-looking behaviors?
- How to manage systems under new fundamental constraints like heterogeneity, limited resources, or random shocks
- How to reveal signals of critical changes
- How to integrate knowledge from models viewing a complex system from different perspectives

Area A will also develop techniques for the use in IIASA's research in the forthcoming fields of Food and Water, Energy and Climate Change, and Poverty and Equity.

DYN's research activities in area B (Economic Dynamics) will be preparing a basis for future ASA-based studies in the field of Economic Growth and Globalization, constituting part of IIASA's new initiative of Driving Forces of Global Transformation. Research will be carried out in collaboration with the POP Program and will further develop DYN-POP's earlier established initiative on Driving Forces of Economic Growth.

DYN's research activities in area C (Ecological Dynamics and Environmental Management) will be developing a background for future ASA-based applications to Food and Water.

Personnel Resources

Scientific Staff

Arkady Kryazhimskiy (Russia), Program Leader
Sergey Aseev (Russia)
John Casti (USA)
Alexey Davydov (Russia)
Brian Fath (USA)
Kateryna Gumeniuk (Ukraine)
Leena Ilmola (Finland)
Andrey Krasovskiy (Russia)
Yaroslav Minullin (Russia)
Manuel Ortiz Moctezuma (Mexico), Colosio Fellow
Tapio Palokangas (Finland)
Elena Rovenskaya (Russia)
Gerald Silverberg (USA)
Alexander Tarasyev (Russia)
Chihiro Watanabe (Japan)

YSSP

Benjamin Allen (USA)
Vasileios Dakos (Greece)
Min Hong (China)
Irina Petrenko (Russia)

Administrative Support

Angela Dowds (United Kingdom)

Publications[1]

Journal Articles

Baird D, Fath BD, Ulanowicz RE, Asmus H & Asmus R (2009). On the consequences of aggregation and balancing of networks on system properties derived from ecological network analysis. *Ecological Modelling*, 220(23):3465-3471 (10 December 2009).*

Davydov A, Danchenko V & Zvyagin M (2009). Existence and uniqueness of a stationary distribution of a biological community. *Proceedings of the Steklov Institute of Mathematics*, 267(1):40-49 (December 2009).*

Lehmijoki U & Rovenskaya E (2009). Air pollution mortality in Denmark, Finland and Sweden. *Finnish Yearbook of Population Research 2009*, XLIV:97-108.*

Lobanova G, Fath BD & Rovenskaya E (2009). Exploring simple structural configurations for optimal network mutualism. *Communications in Nonlinear Science and Numerical Simulation*, 14(4):1461-1485 (April 2009).*

Scharler UM & Fath BD (2009). Comparing network analysis methodologies for consumer-resource relations at species and ecosystems scales. *Ecological Modelling*, 220(22):3210-3218 (24 November 2009).*

Other Publications

Aseev SM (2009). Infinite-Horizon Optimal Control with Applications in Growth Theory (Lecture Notes). MSU CMC Publications Department, MAKS Press, Moscow, Russia.

Casti J (2009). Fast tracks to the Stone Age. *Options* (IIASA, Laxenburg, Austria), Summer 2009, pp. 8-9.

Kryazhimskiy A & Osipov Y (2009). Problems of optimal control with incomplete information and method of program packages (Abstract). In: *Actual Problems of Stability and Control Theory (APSCT'2009): Abstracts of International Conference*, 21-26 September 2009, Institute of Mathematics and Mechanics, Ural State University, Ekaterinburg, Russia, pp. 100-102 [in Russian].

Lehmijoki U & Rovenskaya E (2009). Environmental Mortality and Long-run Growth. Discussion Paper No. 252 / February 2009. Helsinki Center of Economic Research, University of Helsinki, Finland.

Conference Proceedings

Watanabe C, Shin J, Heikkinen J & Tarasyev A (2009). Optimal dynamics of functionality development in open innovation. In: *Proceedings of the IFAC CAO'09 Workshop on Control Applications of Optimization (DVD)*. 6-8 May 2009, University of Jyvaeskylae, Agora, Finland.

Interim Reports

Ayres RU & Fleissner P (2009). A Simple Hybrid 6 Sector I-O Model. IIASA Interim Report IR-09-049.

Digas B, Maksimov V & Schrattenholzer L (2009). On Costs and Benefits of Russia's Participation in the Kyoto Protocol. IIASA Interim Report IR-09-001.

Hong M & Fath BD (2009). Measurement and Spatial Distribution of Urban Land Use Compactness in Chaoyang District of Beijing, China. IIASA Interim Report IR-09-048.

Kryazhimskiy A (2009). On a Boundedly Rational Pareto-Optimal Trade in Emission Reduction. IIASA Interim Report IR-09-017.

McNerney J (2009). Network Properties of Economic Input-Output Networks. IIASA Interim Report IR-09-003.

Pavlova Y (2009). Business-as-usual, High Technology and Coalition Scenarios for Transboundary Pollution in the European Union. IIASA Interim Report IR-09-016.

1 *) Peer Reviewed

Scientific Recognition

Sergey Aseev

Editorships, memberships

- Deputy Editor-in-Chief, *Proceedings of the Steklov Mathematical Institute*
- Member, IFAC Technical Committee 2.4 "Optimal Control" (TC 2.4)
- Member, Organizing Committee, International School "Economic Growth: Mathematical Dimensions," Moscow State University, 5–26 July 2009

Invited lecture

- Infinite-horizon optimal control with applications in growth theory, Lecture course, International Summer School "Economic Growth: Mathematical Dimensions," Moscow State University, 5–26 July 2009, Moscow, Russia

Sergey Aseev and Tapio Palokangas

Invited lecture

- "Two-sector optimal economic growth model with a random price shock" (co-authored with K.Besov, S.-E. Ollus), Viennese Vintage Workshop on Heterogeneous Dynamic Models of Economic and Population Systems, Vienna, 4–5 December, 2009

Alexey Davydov

Editorships, memberships

- Editorial Board, *Journal of Dynamical and Control Systems*
- Editorial Board, *Izvestia: Mathematics*
- Vice-Chairman, International Conference on Mathematical Control Theory and Mechanics, Suzdal, Russia, 3–7 July
- Member, Moscow Mathematical Society
- Member, American Mathematical Society

Invited lectures

- "First-order implicit ODE's and their applications," Minicourse, SISSA, Trieste, Italy, April 2009
- "Cyclic processes: Averaged optimization and profit singularities," University of Durham, Durham, UK, 29 May 2009.
- "Cyclic processes: Averaged optimization and profit singularities," University of Leeds, UK, 17 June 2009.
- "First order implicit differential equations: Normal forms and applications," University of Warwick, UK, 19 June 2009
- "Foliations defined by implicit differential equations," International School and Conference on Foliations, Dynamical Systems, Singularity Theory and Perverse Sheaves, Samarkand, Uzbekistan, 6–21 October 2009

Brian Fath

Editorships, memberships

- President, North American Chapter of International Society for Ecological Modelling
- Associate Editor-in-Chief, Elsevier, *Encyclopedia of Ecology*
- Editor-in-Chief, *Ecological Modelling Journal*
- Member, Editorial Board, *The Scientific World Journal*
- Member, Editorial Board, *International Journal of Ecodynamics*
- Member, Board of Directors, *International Environmental Modelling and Software Society*
- Member, Baltimore County Commission on Environmental Quality (CEQ)

Invited lectures

- "Ecosystem thermodynamics,"Beijing Normal University, Beijing, China, 12 January 2009
- "Interfaces of integrated modelling: Improving socio-economic-environmental models to protect ecosystem services," Conference on Modelling Ecosystem Services, Lecce, Italy, 26–29 May 2009

Andrey Krasovskii and Alexander Tarasyev

Invited lecture

- "Optimal control of logistic growth trends," Viennese Vintage Workshop on Heterogeneous Dynamic Models of Economic and Population Systems, Vienna, 4–5 December 2009

Arkady Kryazhimskiy

Editorships, memberships

- Member, Editorial Board, *Journal of Computational Mathematics and Mathematical Physics*
- Member, Editorial Board, *International Game Theory Review*
- Member, Program Committee, International Conference on Actual Problems of Stability and Control Theory, Ekaterinburg, 21–26 September 2009
- Scientific supervisor; Member, Program Committee, International School, Economic Growth: Mathematical Dimensions, Moscow, 5–26 July 2009
- Acting Member, Russian Academy of Sciences

Invited lectures

- International Institute for Applied Systems Analysis in the context of Electronic Geophysical Year, International Conference on Results of the Electronic Geophysical Year, Pereslavl-Zalesskiy, Russia, 3–6 June 2009

- "Problems of optimal control with incomplete information and method of program packages,"International Conference on Actual Problems of Stability and Control Theory Ekaterinburg, 21–26 September 2009 (co-authored with Yu. Osipov)

Tapio Palokangas and Alexander Tarasyev

Editorship

- Invited editors of the book, Dynamic Systems, *Economic Growth and the Environment*, Springer Series on "Dynamic Modeling and Econometrics in Economics and Finance" (co-editor Jesus Crespo Cuaresma)

Tapio Palokangas

Editorships, membership

- Associate Editor, *European Economic Review*
- Associate Editor, *E-Economics*
- Member, Program Committee, IFAC Workshop on Control Applications of Optimisation (CAO'09), University of Jyväskylä, Finland, 6–8 May 2009

Elena Rovenskaya

Membership

- Member, Organizing Committee, International School,Economic Growth: Mathematical Dimensions, Moscow State University, 5–26 July 2009

Invited lecture

- "An extreme shifting-based numerical algorithm for solving a class of non-convex optimization problems," Towson University, MD, USA, 30 March 2009.

Gerald Silverberg

Invited lectures

- "Innovation as a complex collective search process," Models of Man for Evolutionary Economics, Konrad Lorenz Institut, Altenberg, Austria, 27 September 2009
- "Darwin among the machines: The Butlerian conjecture as metaphor and model," Conference on 150 Years after Darwin: From Molecular Evolution to Language, IFISC, Palma de Mallorca, 22–27 November 2009
- "Bistability and phase transitions in economics and finance and Phase transitions in networked financial systems: An explanation of financial meltdown," Alternative Approaches to Macroeconomic and Micro-Macro Links, DIME RAL 3 WP 3.4 Workshop, Pisa, Italy, 22–23 July 2009

Alexander Tarasyev

Memberships

- Chairman, Technical Committee Optimal Control (TC 2.4), International Federation of Automatic Control (IFAC)
- Chairman, Program Committee, IFAC Workshop on Control Applications of Optimisation (CAO'09), University of Jyväskylä, Finland, May 6-8, 2009
- Member, Organizing Committee, International Conference on Actual Problems of Stability and Control Theory, Ekaterinburg, 21–26 September 2009

External Research Contracts above €10,000

Title	Funder	Date From	Date To	Total (€)	2009 (€)
Minullin Support	Institute for Energy and Finance	01.11.2008	30.04.2009	21,707	14,471

Transition to New Technologies Program

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

Objectives

The strategic goal of the TNT Program is to further the understanding of the patterns, drivers, constraints, and impacts of technological change, particularly in the areas that are key for framing global sustainability conditions (such as climate change) and to disseminate policy-relevant research findings through high-level global forums and participation in major international scientific assessments.

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 strategic research goal consequently focuses on the systemic aspects of technological change and draws on empirical case studies, associated "meta" analysis, novel modeling approaches, as well as scenario studies and robustness analysis to inform technology policy choices from a systemic perspective.

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 and actor heterogeneity, and assessments of the potential economic and societal impacts that could result from pervasive diffusion and adoption of new technologies. Priority is given to those technology areas that maximize synergies and cooperation with other IIASA research programs, in particular, in the energy and climate areas. In terms of methodology, priority is given to prototyping novel modeling concepts in areas where TNT staff have a specific comparative advantage, including modeling of spatial phenomena ("downscaling") as well as agent-based modeling approaches to technological complexity.

A final objective of TNT is to maximize the visibility of its small research staff through participation in a few key international assessments and collaborative activities, most notably the Intergovernmental Panel on Climate Change (IPCC) and the Global Energy Assessment (GEA), including software development for scientific data documentation and dissemination.

Scientific Achievements in 2009

Highlights

Research highlights for 2009 include a highly successful workshop in the Economics of Technologies to Combat Global Warming, important progress on two knowledge modules for the GEA (on technology innovation policy and on urbanization) due to be published in 2010; completion of the scenario database software for the IPCC representative concentration pathways (RCP) and posting of the database on IIASA's Web site as a service to the wider scientific community; and a series of publications reporting on multi-year historical empirical research efforts on the dynamics of technology costs and scaling patterns. Finally, two externally sponsored research grants were also received in 2009: the European Union–funded MONITOR project that assesses scenario and technology trends relevant for global aviation, as well as a grant to support TNT input to the work of the policy-influential German Advisory Board on Global Change (WBGU).

Workshops

A major international workshop on **The Economics of Technologies to Combat Global Warming** was held in Snowmass, Colorado, on 4–5 August 2009. It was co-convened by TNT researcher (and IIASA deputy director) **Nebojsa Nakicenovic** and Bill Nordhaus from Yale University and funded by the United States–based Kauffman Foundation. 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. A publication in a special issue of the journal Energy Economics is planned for 2010, following the model of earlier jointly organized technology workshops that were summarized in a book published by RFF Press.

A summary on the workshop convened by TNT in 2008 on methane hydrates was also published in 2009 in *Environmental Research Letters*, receiving extensive quotations and media coverage.

Global Energy Assessment (GEA)

Within the context of the Global Energy Assessment (see ENE activity report for more details), TNT has received the distinction of coordinating two knowledge modules (KMs, to be chapters of the final published report). **Arnulf Grubler** serves as convening lead author (CLA), on KM18 on urbanization and KM24 on technology innovation policy. Other TNT scientists serving as lead and contributing authors for the two GEA KMs include **Niels Schulz** and **Vadim Chirkov**. TNT researcher and ENE Acting Program Leader **Keywan Riahi** serves as CLA on GEA's scenario chapter that assumes a central synthesizing and coordinating role across the various topics addressed within GEA. All TNT scientists are also actively contributing to this KM as well.

Important progress was achieved on all three GEA KMs in 2009.

A second order draft (SOD) of the technology innovation policy KM24 was completed and sent for external peer review. Among the hallmarks of the chapter is a comprehensive literature review a series of new case studies that shed light into the policy failures and successes of energy technology innovation initiatives, synthesized to specific lessons for technology policy

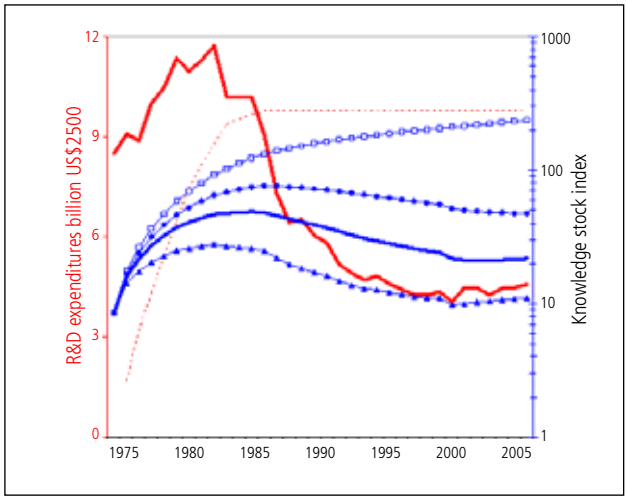


Figure 1. R&D expenditure on nuclear energy in countries of the International Energy Agency (IEA) (billion US$2005) (red, left axis) and estimates of remaining technology knowledge stock (index, blue, right axis) at various rates of knowledge depreciation of 0, 10, 20, and 40% per year (in decreasing order). Note in particular the significant knowledge depreciation as a result of R&D support volatility. The dashed red line indicates the calculated R&D expenditure to maintain the technology knowledge stock at a mean knowledge depreciation rate of 20%/year.

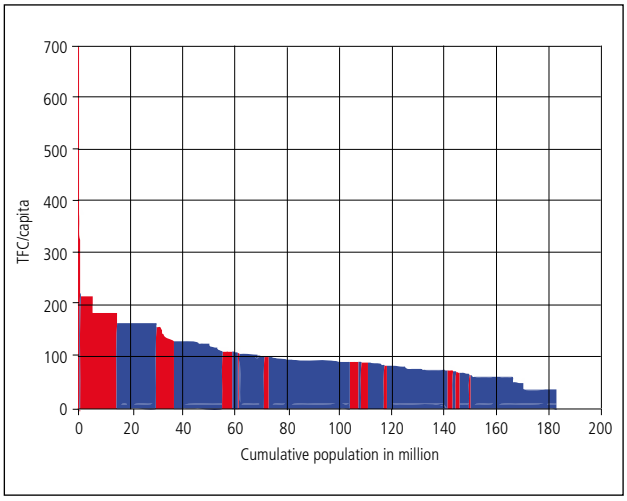


Figure 2. Per capita final energy use in a sample of 126 Cities in UNFCC Annex-I countries. Red bars denote values above respective national average; blue bars indicate city values below national average. Note in particular the large number of cities (107 in the sample of 126) in which the urban energy (and GHG emission) footprint is some 30% **below** the respective national average (85 vs 120 GJ/capita) suggesting that urban resource use patterns in many cities of Annex-I countries may have already progressed further in the direction of enhanced sustainability than non-urban areas.

design in KM24. An illustrative highlight (developed by Arnulf Grubler in collaboration with TNT alumnus **Greg Nemet**) is shown in *Figure 1* depicting the knowledge depreciation of nuclear-related R&D in the countries of the Organisation for Economic Co-operation and Development (OECD). Volatility in R&D support can be a significant source of knowledge depreciation, which remains a serious problem for innovation policy design and one that must be guarded against.

The SOD of the urbanization KM18 will be sent out for external peer-review in the spring of 2010. The KM, which is the very first to address the critical issue of urbanization in an major international assessment, contains a number of novel features including a unique database of urban energy use (*Figure 2*), spatially explicit energy density maps, and results from a new model of urban evolution developed by collaborators at Imperial College in London that combines elements of both agent-based and optimization techniques to simulate the impacts of urban policy interventions.

Progress on the GEA scenario work (KM17) is reported in the Progress Report of the ENE Program. TNT contributors included Arnulf Grubler (scenario design, technology modeling and scenario assumptions), Vadim Chrikov (spatially explicit modeling), Tieju Ma (model and software development for economic growth indices, in particular purchasing power parities), and Peter Kolp (GEA scenario data base design and implementation).

New Empirical Findings

The year 2009 saw the first publication of two multi-year empirical technology research projects that have provided both new data sets for subsequent further analysis by the larger scientific community and new policy insights.

At a time of increased interest in a potential nuclear "renaissance" it seems appropriate to examine in closer detail the economics of the French nuclear scale-up, which is generally agreed to be the most successful example of all OECD countries, but the costs of which have been shrouded in mystery for decades. Drawing on year-long research in the French archives, Arnulf Grubler recently completed a first draft of an economic assessment of the French nuclear PWR (pressurized water reactor) program. The results are of significance both for technology modeling and policy. In the course of the French program specific reactor construction costs increased substantially in real terms despite a stable and favorable regulatory and institutional environment. While the cost escalation is lower than in other countries (especially the USA), even this most successful program for substantial build-up of nuclear capacity in an OECD country is characterized by "negative" learning (i.e., costs increase rather than decrease with increasing technology deployment). The results suggest that intrinsic technology characteristics as well as institutional factors are the main determinants of the economics of large-scale, complex technologies, with the effects of classical economies of scale or standardization and series effects being small. The results also suggest that current nuclear cost projections could be substantially overoptimistic.

As a second example of TNT empirical technology research, a recent first paper written by **Charlie Wilson** deserves special mention. Begun when he was working on a YSSP project in 2008 and continued through 2009, the paper analyzes historical examples of technology scaling (at the level of individual technologies as well as at the level of entire industries) for a number of key markets and selected energy supply and end-use technologies over the last 100 years. The study identified a char-

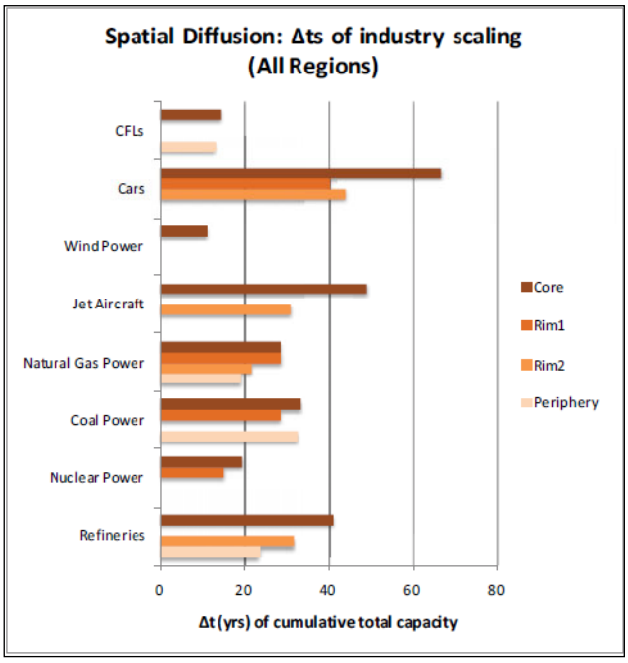


Figure 3. Diffusion speed (time in years to grow from 10 to 90 percent of installed cumulative capacity) between innovating core regions and later-adopting rim and periphery regions for a range of technologies (CFLs denoting compact fluorescent light bulbs). The generally faster diffusion rates in non-core regions indicate the existence of important learning externalities that could accelerate the diffusion of environmentally more benign technologies in developing countries.

acteristic scaling pattern as well as a remarkable consistency between extent and rates of technology and industry scaling that appear invariant across technologies or regional markets: this suggests a useful guideline for assessing the plausibility of scenarios of technological change, or of "systems response times" to policy signals that might be much swifter than hitherto assumed by climate change policy models. Another important finding concerns the spatial diffusion of new technologies, where peripheral regions can benefit from learning externalities yielding much faster adoption of new technologies compared to the innovating core regions (*Figure 3*). This empirical finding corroborates theoretical models and could be welcome news for efforts to involve developing countries in a comprehensive international GHG control regime.

As a last example of new TNT empirical research findings and illustration of the promise of young, next-generation researchers, the publication of Jordan Macknick on CO_2 emission inventory uncertainties is highlighted here. The publication and its associated downloadable database provide an easy-to-use and powerful overview of the uncertainties across all major international emission inventories and extends earlier findings published in the *Proceedings of the National Academy of Sciences (PNAS)*. These emission uncertainties are still insufficiently reflected in climate policy and could constitute a substantial source of carbon price uncertainty and volatility that are detrimental for technology innovation and adoption incentives for low-emission technologies.

Software Development

Scientific software development that assists in science communication has become a hallmark of TNT's research output. Peter Kolp completed new interactive Web-based software and data interface software to document the new IPCC RCP scenarios (see also ENE Progress Report) that are hosted on IIASA's Web site. The software (for an illustrative screenshot see *Figure 4*) sets new standards in the documentation of scientific results and has become a major tool in international and interdisciplinary collaboration among climate scientists, modelers, and policy analysts. A distinguishing novel feature of the IPCC RCP data base is that it also includes spatially explicit projections of all radiatively relevant gases that are needed as inputs to Earth systems and climate models. TNT researcher Vadim Chirkov has developed the spatially explicit emission projections for the IIASA RCP scenario in collaboration with ENE researchers.

External Contracts

Two external research grants were received in 2009. The first from DG Research, European Union, aims at the development of a "Monitoring System on the Development of Global Air Transport (MONITOR)" that is highly relevant both for the study of new technology trends in aviation and from a climate change perspective. The project is coordinated by the German Aerospace Center (DLR). A second contract was received from the German Advisory Board on Global Change (WBGU) to support the participation of Nebojsa Nakicenovic, assisted by Niels Schulz, in a major study on transformative change (see also section on Policy Impact below).

Policy Impact in 2009

Two activities had a particularly strong science policy impact in 2009.

Nebojsa Nakicenovic was appointed to the Committee on Scientific Planning and Review of ICSU, the International Council for Science. In this capacity he will help develop major new international scientific initiatives, review the activities of ICSU's scientific interdisciplinary bodies, and advise the ICSU Executive Board. ICSUs key role in the coordination of major international research programs and initiatives make this advisory role of particular relevance for science policy.

Nakicenovic was also appointed to the German Advisory Board on Global Change (WBGU). There are few scientific bodies in Europe able to exert a larger policy influence than the WBGU, which regularly interacts with highest-level policymakers, particularly on the issue of climate policies. A major new initiative from WBGU is a study on transformative changes associated with climate change mitigation, a topic that falls right into the core research area and expertise of TNT and will be an area of potentially very large policy impact.

Summary of Activities 2009

TNT's in-house research effort in 2009 amounted to 57 person-months. Program researchers taught classes at 5 universities, delivered some 72 lectures, and published 12 peer-

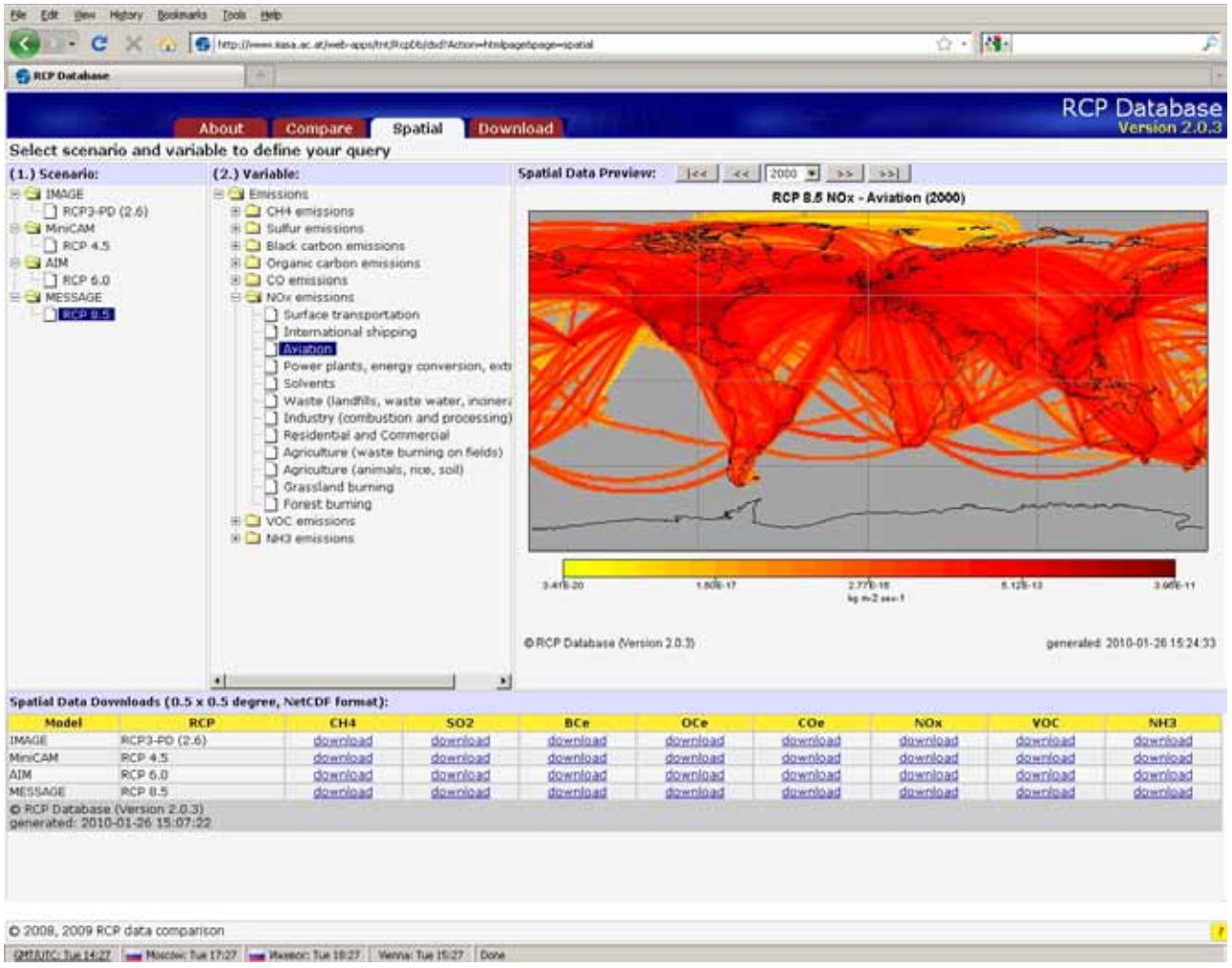


Figure 4. Screenshot from the IPCC RCP scenario database with spatially explicit information (NOx emissions from aviation). The software for this high-visibility service to the wider scientific climate change community was developed by TNT staff in cooperation with ENE researchers. The topic of future developments in global aviation and potential environmental constraints is also subject to the EU-funded MONITOR research project initiated in 2009.

reviewed papers and an additional 15 papers, many of them due to be published in peer-reviewed journals in 2010.

Activities for 2010

The main thrust of TNT research efforts in 2010 will be devoted to the **Global Energy Assessment** with focus on the three knowledge modules coordinated by TNT research staff. As well as completion of the final drafts of the knowledge module texts and conducting an IPCC-style extensive external peer review, additional publications on GEA-related research will be prepared. It is planned to publish the technology case studies that form the backbone of the technology innovation KM as a commercial book. The findings of the urbanization KM are planned to be published as a special journal issue.

A coordinated effort among a range of TNT collaborators during summer 2010 will also be devoted to the development of an extended version 2.0 of the agent-based model of technological complexity in which the combinatorial evolutionary space will be significantly expanded to also include sub-components of the modeled technology traits.

Personnel Resources

Scientific Staff

Arnulf Grübler (Austria), Program Leader (acting)
Vadim Chirkov (Russia)
Tieju Ma (China)
Jordan Macknick (USA)
Nebojsa Nakicenovic (Austria)
Keywan Riahi (Austria)
Niels Schulz (Germany)
Charles Wilson (United Kingdom)

Postdoctoral Research Scholar

Christopher Doll (United Kingdom)

YSSP

Patrick Sullivan (USA), co-supervised with ENE
Jun Wan (China)

Scientific Support

Peter Kolp (Austria)

Administrative Support

Katalin David (Australia)
Sheila Poor (Austria)
Patricia Wagner (USA)

Publications[1]

Journal Articles

Cantono S & Silverberg G (2009). A percolation model of eco-innovation diffusion: The relationship between diffusion, learning economies and subsidies. *Technological Forecasting and Social Change*, 76(4):487-496 (May 2009). [ENE]*

Grubler A (2009). Determinants of the future of fossil extractive industries. *BHM Berg- und Huettenmaennische Monatshefte*, 154(6):243-248 (June 2009).*

Keirstead J & Schulz NB (2009). London and beyond: Taking a closer look at urban energy policy. *Energy Policy*, Article in press (Published online 12 August 2009). [ENE]*

Krey V, Canadell JG, Nakicenovic N, Abe Y, Andruleit H, Archer D, Grubler A, Hamilton NTM, Johnson A, Kostov V, Lamarque J-F, Langhorne N, Nisbet EG, O'Neill BC, Riahi K, Riedel M, Wang W & Yakushev V (2009). Gas hydrates: Entrance to a methane age or climate threat? *Environmental Research Letters*, 4(3):034007 (7 September 2009). [ENE, GGI, PCC]*

Krey V & Riahi K (2009). Implications of delayed participation and technology failure for the feasibility, costs, and likelihood of staying below temperature targets – Greenhouse gas mitigation scenarios for the 21st century. *Energy Economics*, 31(Supplement 2):S94-S106 (December 2009). [ENE]*

Leduc S, Schmid E, Obersteiner M & Riahi K (2009). Methanol production by gasification using a geographically explicit model. *Biomass and Bioenergy*, 33(5):745-751 (May 2009). [ENE, FOR]*

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Schellnhuber HJ, Messner D, Leggewie C, Leinfelder R, Nakicenovic N, Rahmstorfer S, Schlacke S, Schmid J & Schubert R (2009). *Solving the Climate Dilemma: The Budget Approach (Special Report 2009)*. WBGU, Berlin, Germany. [ENE]

Other Publications

Grubler A & Pachauri S (2009). Problems with burden-sharing proposal among one billion high emitters (Letter). *PNAS*, 106(43):E122-E123 (27 October 2009). [GGI, PCC]*

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1 *) Peer Reviewed
Highlighted publications appear more than once in the IIASA Publications List:
Dark brown entries: IIASA author collaborated with IIASA colleagues from different IIASA programs, identified in brackets.
Light brown entries: IIASA author researches for more than one IIASA program, identified in brackets.

Nakicenovic N (2009). How much technological change, research and development is enough? (Conference paper). In Energy Modeling Forum (EMF): *Snowmass 2009, Session "The Economics of Technologies to Combat Global Warming"*, 3-4 August 2009, Snowmass, CO, USA. [ENE]

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Doll CNH (2009). Spatial Analysis of The World Bank's Global Urban Air Pollution dataset. IIASA Interim Report IR-09-033.

Grubler A (2009). An Assessment of the Costs of the French Nuclear PWR Program 1970-2000. IIASA Interim Report IR-09-036.

Krey V & Riahi K (2009). Risk Hedging Strategies under Energy System and Climate Policy Uncertainties. IIASA Interim Report IR-09-028. [ENE, GGI]

Macknick J (2009). Energy and Carbon Dioxide Emission Data Uncertainties. IIASA Interim Report IR-09-032.

Wilson C (2009). Meta-analysis of Unit and Industry Level Scaling Dynamics in Energy Technologies and Climate Change Mitigation Scenarios. IIASA Interim Report IR-09-029.

Reprints

O'Neill BC & Nakicenovic N (2009). Learning from global emissions scenarios. IIASA Reprint RP-09-002, from *Environmental Research Letters*, 3(2008):045014 (9pp). [ENE, PCC]*

Scientific Recognition

Advisory Boards and Steering Committee Memberships

Arnulf Grubler

- 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

Nebojsa Nakicenovic

- Member, UN Secretary General's Advisory Group on Energy and Climate Change
- 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, National Institute for Environmental Studies (NIES), Japan
- Member of the Panel on Socioeconomic Scenarios for Climate Change Impact and Response Assessments
- Member of the Renewable Energy Policy Network for the 21st Century (REN21) Steering Committee
- Member, Global Energy International Prize Committee, Russian Research Center 'Kurchatov Institute", Moscow, Russia
- Advisory Board Member, Friedrich-Schiedel-Foundation on 'Energy technology', Vienna, Austria
- Advisory Board Member, OMV Future Energy Fund, Vienna, Austria
- Advisory Group Member, European Environment Agency, Copenhagen, Denmark
- Scientific Steering Committee Member, The Global Carbon Project, CSIRO, Canberra, Australia
- Energy Advisory Group Member, Research Center Jülich, Germany
- 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, International Council for Science (ICSU) Working Group 'Energy and Sustainable Societies', Paris, France
- Steering Group Member, Study Group on Energy Technologies in the 21st Century, Phase II, World Energy Council (WEC), London, UK

- 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

- Review Editor of Chapter 10, Intergovernmental Panel on Climate Change Special Report on Renewable Energy Sources and Climate Change Mitigation (IPCC-SRREN)
- Steering Group Member, Integrated Assessment Modeling Consortium (IAMC)
- Steering Group Member, Energy Modeling Forum Study 24
- Steering Group Member, Asia Modeling Exercise (AME)
- Executive Committee Member, Global Energy Assessment, IIASA, Laxenburg, Austria
- Core Writing Team Member, IPCC AR4 Synthesis Report

Journal Editorships

- *Carbon Management*, Editorial Advisory Board Member (A. Grubler)
- *Climate Policy*, Advisory Board member (N. Nakicenovic)
- *Energy Economics*, Associate Editor (K. Riahi)
- *International Journal of Data Mining*, Modeling and Management, Editorial Board Member (T. Ma)
- *International Journal of Energy Sector Management*, Editorial Board Member (N. Nakicenovic)
- *International Journal of the Institution of Civil Engineers* (ICE), Editorial Manager (N. Nakicenovic)
- *International Journal of Knowledge and Systems Sciences*, Editorial Board Member (T. Ma)
- *Journal of Industrial Ecology*, Editorial Board Member (A. Grubler)
- *Technological Forecasting and Social Change*, Advisory Board Member (A. Grubler, N. Nakicenovic)

External Research Contracts above €10,000

Title	Funder	Date From	Date To	Total (€)	2009 (€)
MONITOR Monitoring System on the Development of Global Air Transport	European Commisson DG Research	01.06.2009	31.05.2011	73,377	30,376
Contribution toward participation in WBGU Advisory Board Meeting - Compensation for Nebojsa Nakicenovic	Stiftung Alfred-Wegener-Institut für Polar- und Meeresforschung	01.11.2008	31.12.2009	31,077	31,077

Energy Program

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

Objectives

The overarching goal of the Energy (ENE) Program is to provide scientific and strategic analysis to gain a better understanding of the dynamics of future energy transformations, their main driving forces, enabling factors, barriers, and consequences for the social, economic, and environmental dimensions of human wellbeing.

ENE research areas are at the core of a number of central research themes at IIASA, in particular the integrated assessment of climate change, the analysis of the energy dimensions of poverty, the role of energy services in fostering further economic development, and energy-related uncertainty and risk assessments. The Program's aim is to improve the understanding of viable policy mechanisms, leverages, and portfolios that would permit the transformation of the present energy system to a cleaner and more sustainable one. This involves: 1) holistic scenario analysis based on large-scale systems engineering and integrated assessment modeling to explore trade-offs between the various energy policy objectives (e.g., climate change and energy security), and 2) development of new methodologies for the explicit representation of uncertainties (and associated risks) and demand-side heterogeneity and inequality. While the first research effort is typically geared toward identifying climate change response strategies that are robust against a wide range of uncertainties, the research on heterogeneity is an integral part of ENE's research focus on sustainable access to energy services.

In addition to the core research activities, ENE is hosting and coordinating the international Global Energy Assessment (GEA), the aim of which is to facilitate exchange among energy experts and leading businesses, governments, and international organizations, and to promote the dissemination of leading-edge technical, policy, and strategic advice. GEA involves some 200 Lead Analysts from around the world working together on a comprehensive and integrated assessment of major energy challenges and how societies can embark on more sustainable development pathways.

Scientific Achievements in 2009

IPCC Representative Concentration Pathways (RCP)

The year 2009 was an important one for the finalization of the spatially explicit emissions and land-cover-change projections of the RCPs, which will form the analytical backbone of the climate change projections of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). The RCPs are being developed by four main Integrated Assessment groups in the USA, Asia, and Europe one of which is the ENE Program, which has been selected to provide the highest of the four RCP pathways. The RCPs are the first projections of their kind, with full spatial coverage of land-cover changes as well as pollutant emissions and greenhouse gases; they 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 emission projections, taking into consideration spatial pollution-control policies based on dynamic maps of human exposure. The development of the RCP scenarios has also fostered the continuation of cross-program collaborations, including painstaking exchanges between ENE, LUC, FOR (in 2007 and 2008), and the APD program (in 2009 on pollution trends). The fine spatial resolution of the RCP scenarios permits climate modeling teams within the IPCC to better assess the greenhouse gas (GHG) 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.

The data dissemination for the IPCC-RCP scenarios is organized through the IIASA Web page (http://www.iiasa.ac.at/web-apps/tnt/RcpDb). For this purpose ENE has developed a Web-based data repository in collaboration with Transition to New Technologies (TNT) for the central storage of the RCP data. Through its interactive features for data visualization, the IPCC-RCP database has proven to be a useful tool also as an internal working environment for the IAM modeling teams involved for reviewing the consistency and integrity of scenario projections. The RCP data dissemination activity through the IIASA Web page is providing a unique service to the main climate research communities and has generated significant interest in IIASA's climate-related work beyond the RCPs. In 2009 the database was extended to cover all major information needed by the international climate modeling teams, which started developing the new future climate projections for the IPCC Fifth Assessment Report in 2009. The data extensions of the RCPs in 2009 included, in particular, 1) historical and future emissions and concentrations pathways for aerosols, which were developed in collaboration with the U.S. National Center of Atmospheric Research (NCAR) and the international expert group headed by Jean-François Lamarque; 2) fully harmonized land-cover projections of the RCPs were added to the database in collaboration with the University of New Hampshire, Canada; and finally, 3) the RCPs were also extended to the very long term (2300) in order to enable the exploration of slow climatic processes and potentially irreversible impacts. The latter RCP extensions were developed in collaboration with the Potsdam Institute for Climate Impact Research (PIK), Berlin. The database has attracted considerable interest with more than 20,000 data accesses since it went online.

The finalization of the RCPs is just the initial step in a longer-term process toward integrated climate change scenarios of the IPCC's Fourth Assessment Report (FAR) exploring the role of mitigation, adaptation, vulnerabilities, and uncertainties of the climate response. In 2009 the blueprint of this new scenario

development process was summarized by leading scientists in the field, including ENE staff members Nebojsa Nakicenovic and Keywan Riahi. The paper will appear in the prestigious journal *Nature* in February 2010.

Climate Mitigation Targets for 2050

In 2009 a major ENE study was released. Co-led by Program Leader Keywan Riahi and Brian O'Neill from the National Center for Atmospheric Research (NCAR), USA, the study addresses the persistent problem of linking long-term climate policy targets to the short- and medium-term actions necessary to achieve them. Using the ENE modeling framework, the study identified critical mid-century energy and emission thresholds that, if surpassed, would make particular long-term climate goals unreachable. The findings, published in the latest issue of the journal *Proceedings of the National Academy of Sciences*, links specific mitigation efforts to the likelihood of staying below a range of temperature thresholds. For example, the study shows that under "business as usual" assumptions, a 50 percent likelihood of capping the global average temperature rise at 2°C in 2100, would require the world to reduce global emissions by at least 20 percent by 2050 compared to 2000 levels. However, in another scenario with high demand for energy and land, to have a 50 percent chance of being at or below the 2°C requires emissions to be reduced by 50 percent by 2050. The latter was found to be barely feasible with current technologies. The results from the study also indicate that there might be some additional flexibility for mid-term emission targets compared to, for example, earlier estimates of the IPCC Fourth Assessment Report *(Figure 1*).

The study was presented at the Conference of Parties (COP15) in Copenhagen, and received widespread attention with dozens of stories in print and electronic media, including the prestigious journal *Nature*.

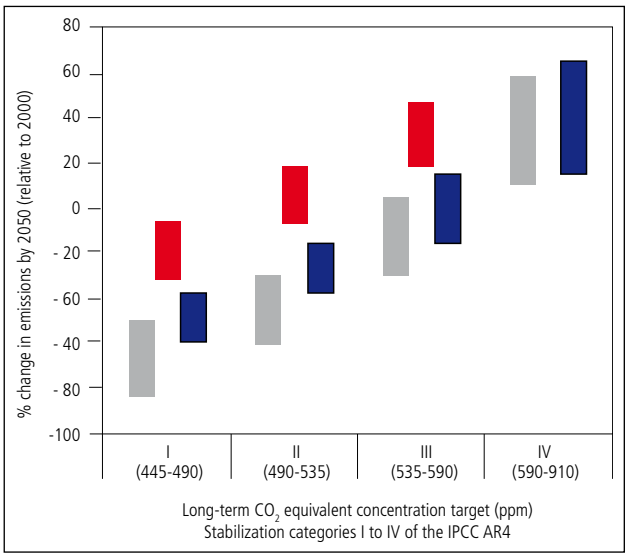

Figure 1: Relationship between mid-century emissions targets and the long-term climate objective (expressed in CO_2-eq concentrations). Red and blue bars indicate the results from the IIASA-NCAR study (*PNAS*, 2009), and the gray bars denote the estimates of the IPCC-AR4. The results from the ENE modeling framework suggest that under certain circumstances emissions by 2050 may be higher than proposed by earlier studies.

International Climate Regimes

Another important study, which was successfully completed in 2009, was the EMF22 (Energy Modeling Forum Study 22). The Study used ten of the world's leading integrated assessment (IA) models to focus on the combined implications of three main factors integral to international climate negotiations: 1) the long-term climate-related target, 2) whether or not this target can be temporarily exceeded prior to 2100 ("overshoot") allowing for greater near-term flexibility, and 3) the nature of international participation in emission mitigation. The EMF22 international scenarios are based on combinations of these dimensions, embodied in ten specific climate-action cases that all modeling groups in the study attempted to represent. The study's overview paper, co-authored by ENE staff member Volker Krey, clearly illustrates that failure to develop a comprehensive, international approach to climate mitigation will constrain efforts to meet ambitious climate-related targets. Without early and comprehensive action by major emitting regions, concentrations may exceed particularly ambitious targets such as those that would limit temperature change below 2°C. The study also explores global and regional climate mitigation costs and finds that the global costs of climate mitigation will be higher without comprehensive action, and that they may be higher not just for the initial entrants but also for those countries that join later along the way. The latter finding is of particular importance in light of the recent failure of the Conference of Parties in Copenhagen (COP15) to define international GHG emission reduction targets.

Collaborative research projects with strategic partners from IIASA's National Member Organization (NMO) countries comprised research on electrification and efficiency strategies with the Tokyo Electric Power Company (TEPCO, Japan); development of a national integrated assessment modeling framework for China in collaboration with Tsinghua University; and the exploration of climate transition pathways for South Asia in collaboration with the Institute of Integrated Research and Action for Development (IRADE) in India.

Global Energy Assessment (GEA): Scenarios

A major research focus during 2009 was the development of the initial set of transformational energy scenarios that form the analytical backbone of the Global Energy Assessment (GEA) with regard to the assessment of future measures and policies (see also next section). The GEA scenarios describe transformative changes of the energy system for the transition toward a more sustainable future. They simultaneously achieve a set of normative goals related to environmental impacts of energy conversion and use, energy security, and energy access. For example, they all stabilize future global mean temperature increase to 2°C above pre-industrial levels and they all lead to universal access by 2030 to energy services throughout the world.

The year 2009 saw an elaborate participatory scenario development process with painstaking exchanges between the Lead Authors of the GEA Assessment and the ENE modeling team to derive initial quantitative projections of the three alternative

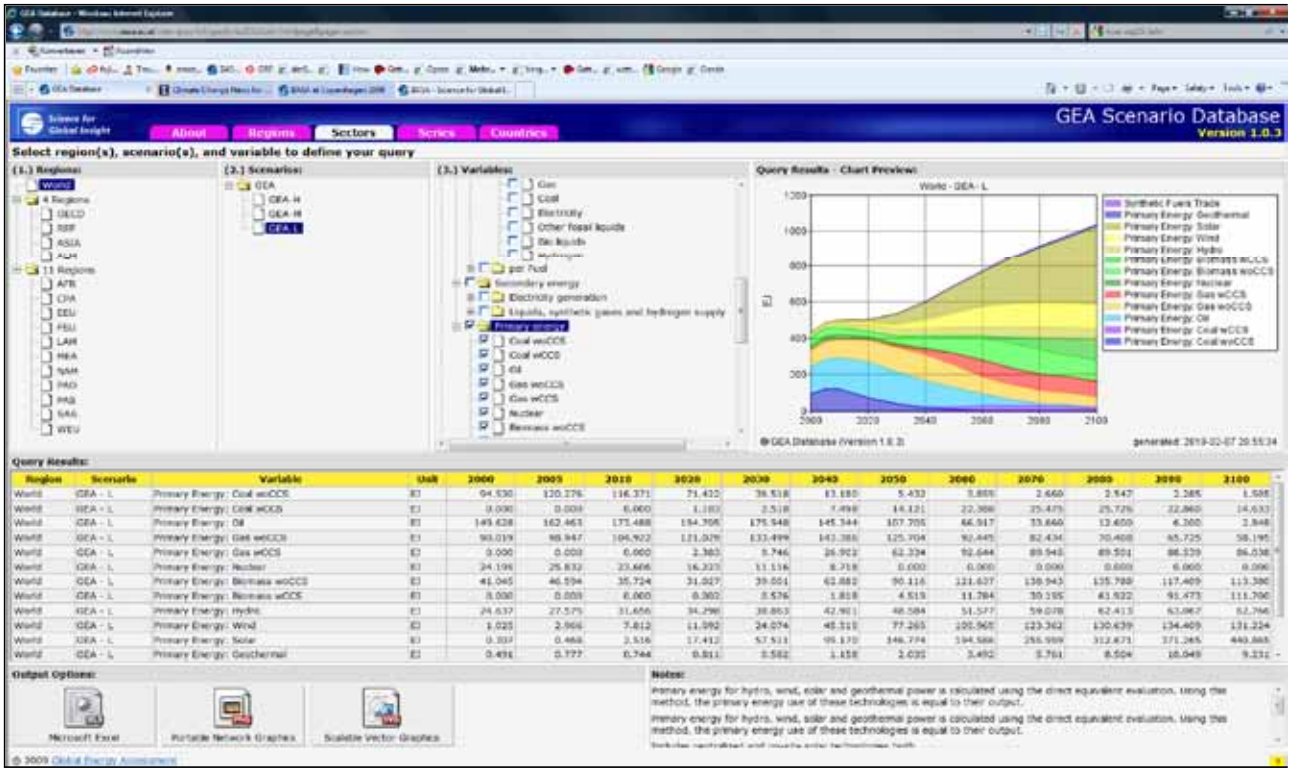

Figure 2: GEA Scenario Database. The interactive Web tool is used by the GEA writing team for internal review, data visualization, and download of key scenario data.

energy transformation scenarios, simply labeled GEA-L, GEA-H, and GEA-M. While all three GEA scenarios are successful with respect to the chosen sustainability objectives, they indicate that the types and scales of energy-related transformations will vary significantly depending upon the key choices that are made with respect to 1) infrastructure, 2) lifestyles, and 3) policy. These choices have in turn widespread implications for issues of technological availability and scale-up; institutional and capacity requirements; and financing needs.

The initial GEA scenario results are made available at an interactive scenario database on the Web (*Figure 2*). The database has proven to be a very useful tool for scenario visualization and data dissemination. The development of the tool builds upon earlier Web-based scenario tools (such as the RCP database) and collaboration with the TNT Program. Presently, the GEA scenario database is used for the internal GEA review by the Lead Authors, and will be opened for the public in 2010 when the final GEA Report is published.

Global Energy Assessment (GEA): Coordination

The Global Energy Assessment (GEA) is a very large, externally funded networking effort within the ENE Program with a total budget of about €1.7 million in 2009. The GEA was established by IIASA-ENE and its partnering organizations around the world, to help decision makers address the challenges of providing energy services for sustainable development. The GEA aims at redefining the energy policy agenda. Initiated in 2005 by an Organizing Committee and formally launched at IIASA in January 2007, it addresses major contemporary energy challenges in an integrated and comprehensive fashion. Recognizing that a number of assessments have approached energy from various standpoints—climate change (IPCC), ecosystems (MEA), or agriculture (IAASTD)—the specific focus of GEA is on energy. GEA gleans insights from these earlier studies to present a unified picture of all the global challenges related to energy, including the global environmental benefits that could be achieved through deployment of advanced energy systems. The aim of GEA is to advise decision makers on constructing a portfolio of policies for dealing with all of the energy-linked challenges simultaneously, adequately, and promptly.

In 2009 approximately 200 analysts in total were working on the GEA, with a truly global representation of a variety of expertise. The analysts are divided into teams led by the Convening Lead Analysts (CLAs) of the Executive Committee who are each responsible for one of the knowledge modules of the Assessment. At present the efforts of the Executive Committee are focused on completing the "second-order draft" of the main analytical report. Thereafter, a formal external peer review will begin, with assigned review monitors then ensuring that the report is revised appropriately to reflect the comments.

Substantively, the Assessment is organized around four knowledge clusters: 1) the major challenges, 2) the technologies and resources available, 3) the energy systems which would combine the technologies and resources to adequately address the multiple challenges, and 4) the policies and measures required to enable a transition to sustainable energy. All four clus-

ters have made progress toward preliminary findings. The clusters address key questions such as: What are the implications of a rapid shift to urbanization and increasing energy densities? What are the key environmental thresholds (or "trigger points") that we are likely to encroach given a continuous increase in economic activity and energy requirements? and, What especially are the implications of the fast growth of emerging economies, such as Brazil, China, and India?

On the question of increasing energy density, high population and income lead to spatial density of energy demand by cities of between 10 and 100 watts per m^2. This energy density is consistent with that of fossil fuel infrastructures and conversion devices, but it is between a factor of 20 to 200 higher than the typical energy densities resulting from the harvesting of renewable energy flows. This implies that if renewable energies are to increasingly supply urban energy needs, the resulting needs for conversion and long-distance transport, as well as very large energy "catchment" areas (the "energy footprint" of cities) will need to be taken into account.

On the question of environmental thresholds, one example that would imply a strong restriction on energy system development, would be interpretations of what constitutes "dangerous" climate change. No international agreement on this topic exists at present, although the European Union has proposed a maximum temperature increase above pre-industrial one of 2°C. Recent scientific literature has been exploring possible temperature increases that might trigger an unstoppable process, for example, the elimination of major inland ice and release of frozen methane well before a 2°C temperature increase has been reached. GEA explores emission pathways compatible with a 2°C temperature increase as well as lower emission pathways to understand the energy system transformation that such objectives would imply.

In 2009 the GEA is also looking at the role of technological innovation—its drivers, resource requirements, impacts, and barriers—in part, through a series of case studies. One finding is that for photovoltaic (PV) electricity, a variety of factors, including government activities, have enabled a reduction in cost of two orders of magnitude over the past five decades. Despite this achievement, the technology remains too expensive compared to existing electricity sources, such that widespread deployment depends on substantial future improvement. No single determinant predominantly explains the improvement to date; R&D, economies of scale, learning-by-doing, and knowledge spillovers from other technologies have all played a role in reducing system costs. Moreover, interactions among factors that enable knowledge feedbacks—for example, between demand subsidies and R&D—have also proven important.

In 2009 GEA activities included four meetings of the Executive Committee, responsible for conducting the analysis and producing the products of the GEA (on 16–18 February, 27–29 April, 10–22 September, and 23–25 November). A highly successful meeting of 100 analysts working on the GEA—roughly half the total working on the Assessment—was held in Vienna on 19–20 June. In addition, over two dozen meetings of the writing teams responsible for the knowledge modules that make up the GEA have taken place.

The work of the Executive Committee is now entering an integrative phase in which the analytical work to date will be synthesized. The GEA will evaluate the competing requirements in economic and social development, environmental protection, and security and construct policy portfolios that can be utilized by decision makers. The scenario exercise that is part of the GEA will also provide an integrative aspect. This phase of the work will stress those interventions and measures that are "win-win"—that is, that simultaneously address two or more energy-linked challenges. For example, policies to provide access to modern cooking fuels will improve indoor air quality for the billion or so people using traditional biomass while simultaneously reducing greenhouse gas emissions. It is estimated that roughly 2 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 moving 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, including China and India, and to a lesser extent in Africa, where a large percentage of households rely on traditional biomass fuels.

The GEA has also succeeded in securing support from a diverse group of stakeholders. It has received financial support from the governments of Austria, Italy, Sweden, and the United States. A number of other countries and the European Commission are being approached. From industry, the World Energy Council, Petrobras, and First Solar Inc. have contributed. Private foundations that have supported GEA include the UN Foundation and the Climate Works Foundation. The World Bank's Energy Sector Management Assistance Program (ESMAP) Trust Fund and a number of UN agencies—UNDP, UNEP and UNIDO—are also financing the GEA. In addition, the Chief Executive Officer of the Global Environment Fund in October approved US$ 1 million in financial support.

Policy Impact in 2009

The ENE Program and the GEA has been highly successful in engaging a range of key stakeholders from government and civil society including the energy industry through one-on-one consultations with key decision makers and through presentations at international conferences. Information on the GEA was presented at the following events: International Scientific Congress on Climate Change (10–12 March 2009, Copenhagen); World Bank Energy Week (31 March 2009, Washington, D.C.); International Energy Conference: Towards an Integrated Energy Agenda Beyond 2020 (22–24 June 2009, Vienna); Special Session of the UN General Assembly on Energy (18 June 2009, New York); Global Forum on Renewable Energy 2009: Scaling-up Renewable Energy (7–9 October, Leon, Mexico); and the UN ECLAC Intergovernmental Meeting "Energy access and poverty reduction to achieve the Millennium Development Goals in Latin America and the Caribbean (20 October, Santiago, Chile). In addition, at COP15 in Copenhagen, GEA was presented at the official side event jointly run with IIASA and TERI on 11 December; at a din-

ner side event on 14 December; at a breakfast hosted by the UN Foundation on 15 December; and at the Alternative COP (Klimaforum09) on 17 December. The GEA Secretariat also publishes a newsletter on a roughly quarterly basis.

Another important side event at COP15 took place on 15 December and was organized by the National Center of Atmospheric Research (USA). Keywan Riahi gave the keynote speech, presenting the findings from a recent IIASA-NCAR study on medium-term GHG emission targets.

In 2009 ENE staff and GEA Director Nebojsa Nakicenovic was appointed to the *UN Secretary-General's Advisory Group on Energy and Climate Change*. The group is advising the UN S-G on policies and measures for reaching specific goals for universal energy access and energy efficiency. In 2009 Nakicenovic also served on the Advisory Board of the World Bank's *World Development Report 2010*, examining how to integrate development realities into climate policy, including international agreements, instruments to generate carbon finance, and steps to promote innovation and the diffusion of new technologies. As a member of the *Expert Panel on Sustainable Energy Supply, Poverty Reduction and Climate Change of the Energy Sector Management Assistance Program* (ESMAP), Nakicenovic assisted the Program in achieving its objectives to provide policy advice on sustainable energy development to governments of developing countries and economies in transition. Finally, besides being on various other scientific steering committees in 2009, Nakicenovic was also the Chair of the Advisory Board, *OMV Future Energy Fund*, Vienna, Austria. The Future Energy Fund has the important role in identifying renewable energy and emission reduction projects within the OMV group, supports their implementation, and provides funding for them.

Activities for 2010

Research activities in 2010 will primarily focus on the further development of the GEA scenarios with focus on improved representation and better understanding of interactions between diverse policy priorities, including especially energy poverty, energy security, and climate change. Emphasis will be given to the identification of robust policy packages with significant ancillary benefits and thus "win-win" solutions. Besides scenario development, the writing of a whole Knowledge Module of the GEA on future transition pathways will be coordinated by ENE in 2010.

ENE will participate also in 2010 in the Asian Modeling Exercise of the Integrated Assessment Modeling Consortium (IAMC) as a steering member and participating modeling team. In collaboration with local experts, the scenario and modeling activity aims at a better understanding of climate mitigation potentials of the emerging economies in Asia, such as China and India.

Personnel Resources

ENE

Scientific Staff

Keywan Riahi (Austria), Program Leader (acting)
Roberto Aguilera (Canada)
Patrick Bell (USA)
Vadim Chirkov (Russia)
Cheol Hung Cho (Korea, Republic of)
Sei Fujisawa (Japan)
Volker Krey (Germany)
Yu Nagai (Japan)
Nebojsa Nakicenovic (Austria)
Martin Offutt (USA)
Shilpa Rao-Skirbekk (India)
Manfred Strubegger (Austria)
Li Yue (China)
Sheng Zhou (China)
Bing Zhu (China)

YSSP

Benjamin Bryant (USA)
David McCollum Jr (USA)
Zoe Chafe (USA), co-supervised with GGI
Patrick Sullivan (USA), co-supervised with TNT

Scientific Support

Peter Kolp (Austria)

Administrative Support

Sheila Poor (Austria)
Patricia Wagner (USA)

GEA

Scientific Staff

Roberto Aguilera (Canada)
Gerald Davis (United Kingdom), GEA Co-President
Jose Goldemberg (Brazil), GEA Co-President
Thomas Johansson (Sweden), GEA Co-Chair
Nebojsa Nakicenovic (Austria), GEA Director
Martin Offutt (USA)
Shonali Pachauri (India)
Anand Patwardhan (India), GEA Co-Chair
Niels Schulz (Germany)
Luis Gomez Echeverri (Austria), GEA Executive Coordinator

Administrative Support

Patricia Wagner (USA)

Publications[1]

Journal Articles

Aguilera RF (2009). Assessing oil resources in the Middle East and North Africa. *OPEC Energy Review*, 33(1):47-69 (March 2009).*

Aguilera RF (2009). Oil supply in Central and South America. *Energy Policy*, 37(8):2916-2925 (August 2009).*

Cantono S & Silverberg G (2009). A percolation model of eco-innovation diffusion: The relationship between diffusion, learning economies and subsidies. *Technological Forecasting and Social Change*, 76(4):487-496 (May 2009). [TNT]*

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Keirstead J & Schulz NB (2009). London and beyond: Taking a closer look at urban energy policy. *Energy Policy*, Article in press (Published online 12 August 2009). [TNT]*

Krey V, Canadell JG, Nakicenovic N, Abe Y, Andruleit H, Archer D, Grubler A, Hamilton NTM, Johnson A, Kostov V, Lamarque J-F, Langhorne N, Nisbet EG, O'Neill BC, Riahi K, Riedel M, Wang W & Yakushev V (2009). Gas hydrates: Entrance to a methane age or climate threat? *Environmental Research Letters*, 4(3):034007 (7 September 2009). [GGI, PCC, TNT]*

Krey V & Riahi K (2009). Implications of delayed participation and technology failure for the feasibility, costs, and likelihood of staying below temperature targets – Greenhouse gas mitigation scenarios for the 21st century. *Energy Economics*, 31(Supplement 2):S94-S106 (December 2009). [TNT]*

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van Vuuren DP, Hoogwijk M, Barker T, Riahi K, Boeters S, Chateau J, Scrieciu S, van Vliet J, Masui T, Blok K, Blomen E & Kram T (2009). Comparison of top-down and bottom-up estimates of sectoral and regional greenhouse gas emission reduction potentials. *Energy Policy*, 37(12):5125-5139 (December 2009). [TNT]*

Books

Schellnhuber HJ, Messner D, Leggewie C, Leinfelder R, Nakicenovic N, Rahmstorfer S, Schlacke S, Schmid J & Schubert R (2009). *Solving the Climate Dilemma: The Budget Approach (Special Report 2009)*. WBGU, Berlin, Germany. [TNT]

Other Publications

Fujisawa S & Krey V (2009). Investigation of Emission Reduction and Uncertainties of Global Electrification Scenarios. Interim Report, Tokyo Electric Power Company (TEPCO) (September 2009).

Gomez-Echeverri L & Offutt M (2009). The energy to combat climate change. *Options* (IIASA, Laxenburg, Austria), Winter 2009/2010, pp. 14-15.

Hurtt GC, Chini LP, Frolking S, Betts R, Fischer G, Kindermann G, Kinoshita T, Riahi K, Shevliakova E, Smith S, van Vuuren DP, Wang YP, et al. (2009). Harmonisation of global land-use scenarios for the period 1500-2100 for IPCC-AR5. *iLEAPS Newsletter* (University of Helsinki, Finland), 7:6-8 (June 2009). [FOR, LUC, TNT]

Lamarque J-F, Granier C, Bond T, Eyring V, Heil A, Kainuma M, Lee D, Liousse C, Mieville A, Riahi K, Schultz M, Smith S, Stehfest E, Stevenson D, Thomson A, Van Aardenne J & Van Vuuren D (2009). Gridded emissions in support of IPCC AR5. IGAC*tivities* (Newsletter of the International Global Atmospheric Chemistry Project), 41:12-18 (May 2009). [GGI, TNT]

Nakicenovic N (2009). How much technological change, research and development is enough? (Conference paper). In Energy Modeling Forum (EMF): *Snowmass 2009, Session "The Economics of Technologies to Combat Global Warming"*, 3-4 August 2009, Snowmass, CO, USA. [TNT]

Nakicenovic N (2009). Supportive measures and policies for developing countries: A paradigm shift. Background paper prepared for World Economic and Social Survey 2009, *Promoting Development, Saving the Planet*. Department of Economic and Social Affairs, United Nations, NY, USA.

O'Neill BC, Riahi K & Keppo I (2009). Mitigation implications of mid-century targets that preserve long-term climate policy options (Abstract). *IOP Conference Series: Earth and Environmental Science*, 6(50):502001 (1 February 2009). [GGI, PCC, TNT]*

Rao S (2009). Scaling up low-carbon investments: Focus on renewable energy in Latin America. Working Paper. UNIDO Global Renewable Energy Forum "Scaling up Renewable Energy", 7-9 October 2009, Leon, Guanajuato, Mexico.

Riahi K (2009). IIASA-hosted database proves a hit with researchers. *Options* (IIASA, Laxenburg, Austria), Winter 2009/2010, p. 26.

Riahi K & O'Neill B (2009). Keeping options open. *Options* (IIASA, Laxenburg, Austria), Summer 2009, pp. 18-19. [PCC]

1 *) Peer Reviewed
Highlighted publications appear more than once in the IIASA Publications List:
Dark brown entries: IIASA author collaborated with IIASA colleagues from different IIASA programs, identified in brackets.
Light brown entries: IIASA author researches for more than one IIASA program, identified in brackets.

van Vuuren DP, Meinshausen M, Plattner G-K, Riahi K & Nakicenovic N et al (2009). Temperature increase of 21st century mitigation scenarios (Abstract). *IOP Conference Series: Earth and Environmental Science*, 6(49):492012 (1 February 2009). [GGI, TNT]*

Interim Reports

Ekholm T (2009). Modelling Household Energy Access in India. IIASA Interim Report IR-09-007.

Keppo I & Strubegger M (2009). Implications of Limited Foresight and Sequential Decision Making for Long-term Energy System Planning: An Application of the Myopic MESSAGE Model. IIASA Interim Report IR-09-006.

Krey V & Riahi K (2009). Risk Hedging Strategies under Energy System and Climate Policy Uncertainties. IIASA Interim Report IR-09-028. [GGI, TNT]

Reprints

O'Neill BC & Nakicenovic N (2009). Learning from global emissions scenarios. IIASA Reprint RP-09-002, from *Environmental Research Letters*, 3(2008):045014 (9pp). [PCC, TNT]*

Scientific Recognition

Advisory Boards, Steering Committees, Other

Volker Krey

- Lead Author, Intergovernmental Panel on Climate Change Special Report on Renewable Energy Sources and Climate Change Mitigation (IPCC-SRREN)
- Steering Committee Member, Energy Modeling Forum Study 24
- Steering Committee Member, Asia Modeling Exercise (AME)
- Lead Author, Global Energy Assessment, IIASA, Laxenburg, Austria

Nebojsa Nakicenovic

- Member, UN Secretary General's Advisory Group on Energy and Climate Change
- 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
- Steering Committee Member, Integrated Assessment Modeling Consortium (IAMC)
- Member of the Panel on Socioeconomic Scenarios for Climate Change Impact and Response Assessments
- Member of the Renewable Energy Policy Network for the 21st Century (REN21) Steering Committee
- Member, Global Energy International Prize Committee, Russian Research Center 'Kurchatov Institute", Moscow, Russia
- Advisory Board Member, Friedrich-Schiedel-Foundation on 'Energy technology', Vienna, Austria
- Advisory Board Member, OMV Future Energy Fund, Vienna, Austria
- Advisory Group Member, European Environment Agency, Copenhagen, Denmark
- Scientific Steering Committee Member, The Global Carbon Project, CSIRO, Canberra, Australia
- Energy Advisory Group Member, Research Center Jülich, Germany
- 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, International Council for Science (ICSU) Working Group 'Energy and Sustainable Societies', Paris, France
- Steering Group Member, Study Group on Energy Technologies in the 21st Century, Phase II, World Energy Council (WEC), London, UK
- 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

- Review Editor, Intergovernmental Panel on Climate Change Special Report on Renewable Energy Sources and Climate Change Mitigation (IPCC-SRREN)
- Steering Committee Member, Integrated Assessment Modeling Consortium (IAMC)
- Steering Committee Member, Energy Modeling Forum Study 24
- Steering Committee Member, Asia Modeling Exercise (AME)
- Member, IPCC WGIII Task Group on New Emission Scenarios, Bilthoven, Netherlands
- Executive Committee Member, Global Energy Assessment, IIASA, Laxenburg, Austria

Editorships of Journals

Nebojsa Nakicenovic

- *Climate Policy*, Advisory Board member
- *International Journal of the Institution of Civil Engineers* (ICE), Editorial Manager
- *International Journal of Energy Sector Management*, Editorial Board Member
- *Technological Forecasting and Social Change*, Editorial Board Member
- Co-editor of the Special Issue on Technological Change and Global Warming in the *Journal of Energy Economics*

Keywan Riahi

- *Energy Economics*, Associate Editor

External Research Contracts above €10,000: ENE

Title	Funder	Date From	Date To	Total (€)	2009 (€)
Investigation of Emission Reduction and Uncertainties of Global Electrification Scenarios	Tokyo Electric Power Company (TEPCO)	09.10.2008	08.07.2010	143,994	76,978
EnerGEO Energy Observation for monitoring and assessment of the environmental impact of energy use	European Commission, DG Research via TNO-Netherlands Organisation for Applied Scientific Research	01.11.2009	31.10.2013	115,378	3,560

External Research Contracts above €10,000: GEA

Title	Funder	Date From	Date To	Total (€)	2009 (€)
Support of the Global Energy Assessment	United States Environmental Protection Agency	01.07.2008	30.06.2009	90,000	45,000
Global Energy Assessment - Second Phase	Austrian Development Agency (ADA)	01.09.2007	31.08.2010	600,000	220,368
Support to the Global Energy Assessment (GEA) Initiative	Ministry for the Environment and Territory	01.07.2008	30.06.2009	100,000	57,158
Contribution towards Global Energy Assessment Initiative	Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (FORMAS)	01.11.2008	31.10.2009	178,970	148,970
Climateworks support for GEA	Climateworks Foundation	01.01.2009	31.12.2009	268,625	268,625
GEA Support from First Solar Inc	First Solar Inc	01.05.2009	31.12.2009	106,914	106,914
Provision of services relating to the cooperation with Global Energy Assessment (GEA) on the development of the industrial sector energy end-use module (UNIDO Project No. XP/GLO/09/002)	United Nations Industrial Development Organization (UNIDO)	01.06.2009	30.04.2012	175,002	11,009
MoU for support toward high-level meeting on 19-20 June and International Energy Conference on 22-24 June 2009	United Nations Industrial Development Organization (UNIDO)	01.07.2009	30.08.2009	27,530	27,530
GEA Support Phase 2	The World Bank	22.07.2009	30.09.2010	139,998	110,860
Global Energy Assessment for the work of Cluster II of the GEA on energy resources and technologies (GEA_GETF)	Global Environment & Technology Foundation	01.10.2009	31.05.2010	370,967	173,046
Small Scale Funding Agreement (SSFA) between UNEP and IIASA Scenario Development	United Nations Environment Programme	11.09.2009	30.06.2010	39,000	29,435

Part IV

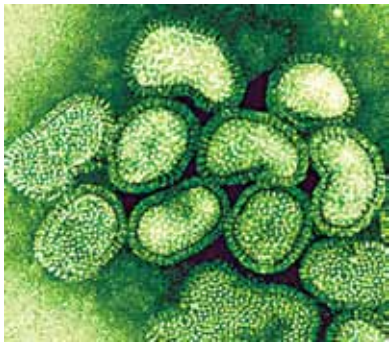
Special Projects

Health and Global Change Project

Landis MacKellar
mckellar@iiasa.ac.at

Objectives

In 2009 the Health and Global Change (HGC) Project's main focus was on establishing HGC as a center of excellence for systems modeling approaches to health, with an emphasis on applied policy work. Among the areas of interest and substantive expertise within HGC are: infectious disease, including malaria, influenza and TB; linkages between health and poverty in the developing world; urbanization and health; external causes of death (suicide, homicide, accidents); and globalization and health. A second major focus for HGC in 2009 was to strengthen its international network through collaborations with various research and policy organizations.



Among the areas of interest and substantive expertise within HGC are: infectious disease, including malaria, influenza and TB.

Scientific Achievements in 2009

Presentations

- A. Noymer and L. Ruppanner. Self-rated health: Is happiness the missing link? Population Association of America, 2009 Annual Meeting, Detroit. Session 166
- D.C. Carreon and A. Noymer. Aging and health for racial minorities: An analysis of the double jeopardy hypothesis using the California Health Interview Survey. Population Association of America, 2009 Annual Meeting, Detroit and American Public Health Association, 2009 Annual Meeting, Philadelphia. Poster Sessions 1 & 3268.0
- J. Siri. Systems analysis of urban malaria. Chinese longevity forum: Environment, development and healthy longevity. Chinese Association for Science and Technology and Chinese Academy of Sciences. Sanshui, China. November 13, 2009.
- M. Spielauer. MicroNPS: Social protection reform for a population of 1.2 billion. A microsimulation analysis. Statistics Canada, Microsimulation Seminar Series, September 28, 2009 & Institute for Economic Growth, Delhi, India, December 7, 2009.

Colloquia and Meetings

- Do social gatherings predict influenza mortality? Andrus Gerontology Center, University of Southern California, 7 November 2009. Institute for Mathematical Behavioral Sciences, UC, Irvine, 12 November 2009. (A. Noymer)
- Who dies in flu pandemics? Evidence from 1918. Stop TB Department, World Health Organization Headquarters, Geneva, 9 September 2009. (A. Noymer)
- The 20th century decline of TB in the USA, with potential comparisons to high- and medium-TB-prevalence countries today. Institute for Population and Social Research, Mahidol University, Salaya, Thailand, 2 September 2009. (A. Noymer)
- Early life influences: How do survivors fare after mortality crises? Office of Population Research, Princeton University, 13 January 2009. (A. Noymer)
- Chinese longevity forum: Environment, development and healthy longevity. Chinese Association for Science and Technology and Chinese Academy of Sciences. Sanshui, China. November 12-13, 2009. (L. MacKellar and J. Siri)
- International Council for Science Urban Health and Wellbeing Planning Group, 4th and 5th planning sessions. Paris, France, May 2009 & Beijing, China, November 2009. (L. MacKellar and J. Siri)
- Vision Summit 2009: Social Business—Another Wall to Fall, Berlin, Nov. 8th, 2009 (S. Ney)

Capacity Building

In 2009 HGC hosted two YSSP students (Courtney Lee and Zachary Brown), of whom the latter subsequently received the Peccei Award for his innovative work on systems modeling of infectious disease. HGC scientist Steven Ney taught a well-received YSSP policy analysis seminar, essentially a "crash course" for students whose main background was in natural and environmental sciences. HGC also hosted a new IIASA postdoctoral fellow, Jose Siri, who is working on infectious disease modeling and urban health. As part of her previous assignment with the U.S. National Academy of Sciences providing backstopping to African academies of science in policy-relevant studies, HGC scientist Clara Cohen provided capacity building to the Nigerian Academy of Sciences in studying child mortality and health systems.

Policy Impact in 2009

Landis MacKellar was responsible for evaluations of EC cooperation strategy in Vietnam, Lao PDR, and the ASEAN region, in which capacity he produced evaluation reports and gave briefings in Hanoi, Vientiane, Jakarta, and Brussels. From September, he was team leader of the continuing mid-term review of the EC Thematic Programme on Migration and Asylum. He provided advisory services for pension system development in Armenia (financed by US AID) and India (financed by the Asian Development Bank).

Andrew Noymer spoke at the Stop-TB programme of WHO HQ (Geneva) in September 2009, on TB-influenza interactions with respect to the current influenza pandemic.

Activities for 2010

In 2010 Martin Spielauer and Landis MacKellar will continue to work with the Institute for Economic Growth in Delhi on micro-simulation of health and poverty in India. It is hoped to form a research partnership in China, with possible South–South exchanges, to implement the same type of approach.

The ICSU Science Plan on Health in the Changing Urban Environment will be completed and, if approved, presented at a kickoff workshop tentatively planned for late 2010/early 2011 at IIASA.

HGC will host the side event of the International AIDS Economics Network (IAEN) at the 18th International AIDS Conference, to be held in Vienna 18–23, July.

In collaboration with the Centre for the Study of Health in Societies in Transition (SCOHOST) of the University of South Stockholm and the Estonian Suicidological Society, HGC will organize a major international conference on suicide as a social and public health problem in Eastern Europe and the CIS. Scholars and policy makers from seven countries in the region are expected to attend the event, scheduled for September. HGC scientist Clara Cohen is taking the lead in this activity.

Andrew Noymer will continue his work in core areas of epidemiologic transition and influenza epidemiology. Numerous scientific articles are in preparation and under review.

Zachary Brown will continue his work on mathematical models of malaria at IIASA in 2010 as a returning Peccei Scholar, and extend his collaboration with Andrew Noymer on influenza dynamics.

Jose Siri will continue his postdoctoral research into urban vector-borne disease, and his participation in the ICSU planning group for Health and Wellbeing in the Changing Urban Environment.

In addition to his research on medical tourism, Steven Ney will begin to systematically compare patterns and impacts of social entrepreneurship in the health care provision in both the developed and developing worlds.

Collaboration

The HGC Project has engaged in three major NMO country collaborations in 2009:

1. HGC scientists Landis MacKellar and Martin Spielauer formed a strategic relationship with the Institute for Economic Growth in Delhi to (i) engage in model-based research on health and poverty in India and (ii) implement a training workshop for mid-ranking Indian researchers on the application of use of micro-simulation modeling approaches in economics and the social sciences.
2. HGC scientist Landis MacKellar chaired the ICSU Planning Committee on Health in the Changing Urban Environment, tasked with producing an ICSU global science plan in this area. He was supported in this by HGC postdoctoral student Jose Siri.
3. HGC scientist Clara Cohen is co-organizing, the Centre for the Health of Societies in Transition (SCOHOST) of the University of South Stockholm, a major international workshop on the public health problem of suicide in Eastern Europe and the CIS.

Personnel Resources

Scientific Staff

Forrest MacKellar (USA), Project Leader
Clara Cohen (USA)
Steven Ney (Germany)
Andrew Noymer (USA)
Ndola Prata (USA)
Isolde Prommer (Austria)
Martin Spielauer (Austria)

Postdoctoral Research Scholar

Jose Siri (USA)

YSSP

Zachary Brown (USA)
Courtney Lee (USA)

Administrative Support

Elisabeth Kawczynski (Canada)
Deirdre Zeller (Ireland)

Publications[1]

Journal Articles

Noymer A (2009). Testing the influenza-tuberculosis selective mortality hypothesis with Union Army data. *Social Science and Medicine*, 68(9):1599-1608 (May 2009).*

1 *) Peer Reviewed

Scientific Recognition

- HGC scientist Andrew Noymer served as a board member of the Society of Biodemography and Social Biology, and a member of the editorial board of *Contemporary Sociology and Biodemography and Social Biology*, and was recognized in Who's Who in America (64th edition. Marquis Who's Who).
- Project leader Landis MacKellar chaired the ICSU Planning Committee on Health in the Changing Urban Environment, tasked with producing an ICSU global science plan in this area. He was supported in this by HGC postdoctoral fellow Jose Siri.

Integrated Modeling Environment Project

Marek Makowski
marek@iiasa.ac.at

Strategic Goal and Objectives

In its fourth year the Integrated Modeling Environment (IME) Project achieved further significant progress in meeting its strategic goal *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 can be decomposed into the following objectives:

1. To integrate and extend the 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. To 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.
3. To 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 up-scaling) technology.

Scientific Achievements in 2009

As the IME objectives are mutually dependent, it is impossible to split IME research so that each research activity can be associated with a specific objective. However, the description of the 2009 activities below is organized according to the main contribution to one of the three IME objectives. Scientific achievements are described in 27 publications of 2009; several more documenting the 2009 research will be published in 2010. The following summary of the research reflect the main results of the IME publications.

Advanced Web-based Modeling Environment

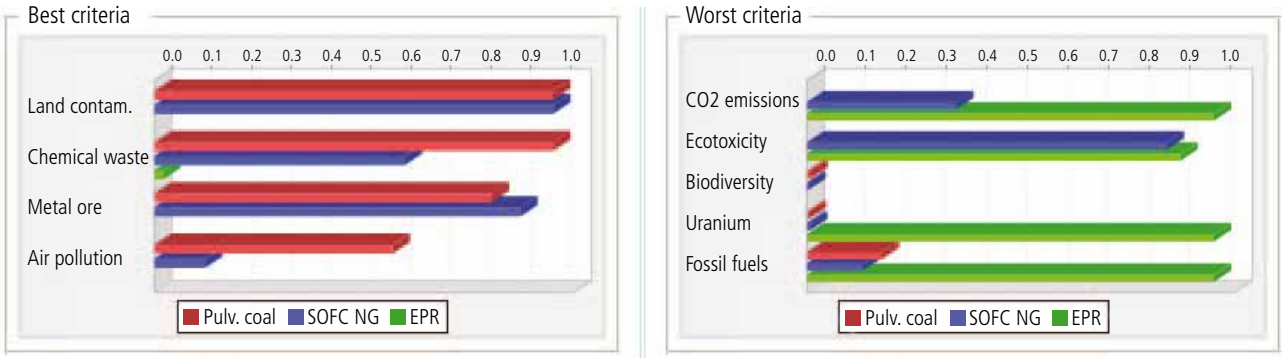
A Web site for interactive multiple-criteria analysis of complex problems of discrete alternatives (complex in the sense of number of criteria and their value distributions, and the number of alternatives) was implemented in 2008 as a dedicated application for public participation in the evaluation of future energy technologies.

This Web site was enhanced in 2009 to provide a general purpose Web site for multiple-criteria analysis of discrete alternatives. Diverse analysis methods were implemented, tested, and documented. Based on the extensive use in 2008, the interface was redesigned to provide the functionality needed for specification of diverse problems as well as for use by those not experienced in analytical methods.

The new Web site was successfully used for capacity-building activities, including the modeling workshop organized in collaboration with the Indian NMO, and workshops with the YSSP participants. The site is now freely available for research and educational purposes.

Coping with Endogenous Uncertainty and Risks

Interconnected socioeconomic and environmental systems are inherently uncertain. Future paths of such systems depend on former and new policies, as well as on exogenously generated uncertainties. Hence, exact predictions of such systems are practically impossible. IME developed new models and methods for the IME Project - 2 - 2009 Progress Report, designing robust solutions, which have a stable performance with respect to multiple indicators characterizing social, economic, environmental and safety criteria.



Multiple-criteria analysis of future European energy technology: A sample of technology comparison in the alternative's space.

Traditional models and methods for decision making under uncertainties and related issues of risk management mainly consider relatively simple systems facing external sources of risks and uncertainties characterized by simple scenario generators. The extension of the existing theory to the case of non-normal multivariate risks, which also may involve multidimensional extreme events and threats generated (intentionally or unintentionally) by various agents, represents a key challenge relevant to numerous new applications, including issues relevant to recent worldwide crises of the financial and economic systems. These issues were the focus of IME studies in 2009, mainly in collaboration with the LUC, FOR, and APD programs, and with colleagues from collaborating institutions. IME also advanced research on catastrophe bond pricing; a new model for supporting the pricing was developed and tested on newly assembled data on the typhoon risk in China.

A book on *Coping with Uncertainties: Robust Decisions* published in 2009 by Springer contains contributions written in collaboration with colleagues from several IIASA programs and from our research network.

Integrated Model Analysis

We continued to develop new methods for multiple criteria analysis by further testing, extending, and documenting the cluster of over 20 new methods developed for the analysis of discrete-choice problems characterized by large numbers of alternatives and criteria. Prototypes of these methods were developed in 2008 to meet the requirements of the EU-funded NEEDS project (that could not be met by any known method). An extensive comparative study of these new methods was done and documented as a methodological basis for advanced users of the MCAA (Multiple Criteria Analysis of Alternatives) Web site. A simple to use interface was also designed and implemented to support such analysis by users without analytical skills.

New methods for fuzzy multiple-criteria analysis were explored by the IME Guest Scholar. Four reports summarize these developments which will be explored further and provide the basis for possible future collaboration.

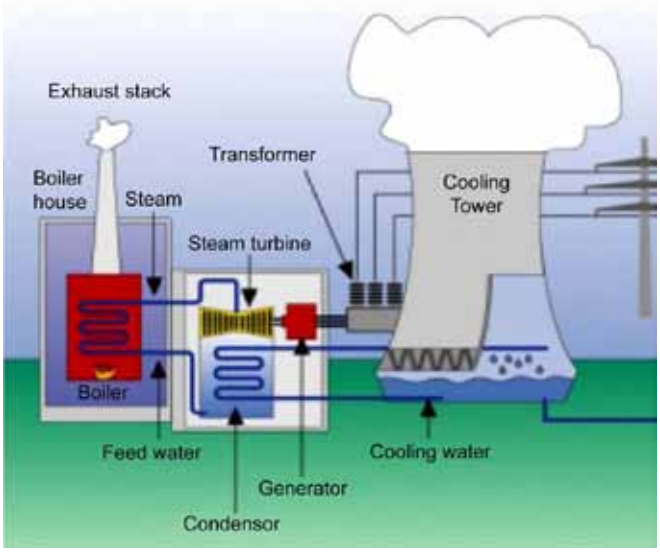
IME also collaborated with the LUC Program in the design and implementation of robust solutions for risk-adjusted planning of sustainable agricultural development in China and Ukraine. Using data from Ukraine, new models and methods were developed for multicriteria assessment of food security under uncertainty. Jointly with the APD, FOR and LUC programs, an integrated model for designing robust CO_2 emission trading under uncertainties and environmental safety constraints was proposed and analyzed using data from European countries, the Russia, and the USA.

Policy Impact in 2009

IME provided key input to the summary report on sustainability assessment of advanced electricity supply options, prepared as policy advice for the EU as the main outcome of the EU-funded project, NEEDS. The basis for the report was analysis of the re-

Coal & Lignite Steam Power Plants – Illustrations

NEEDS
Research Stream 2b



PAUL SCHERRER INSTITUT PSI
Technology Descriptions, Web Survey on Multi-Criteria Preferences
Author contact: warren.schenler@psi.ch
02.10.2008
page 7

Public participation in the multiple-criteria analysis of future European energy technology (the EU-funded NEEDS project): A sample of technology documentation

sults of the public participation in multiple-criteria analysis of future energy technologies (summarized above).

Yuri Ermoliev participated in planning a long-term activity on modeling food, water, and energy security in Ukraine, organized by the Ukrainian Committee on Systems Analysis. This activity involves the leading institutes of the Ukrainian National Academy of Sciences, including the Institute of Economics and Forecasting, the Remote Sensing Institute, the General Energy Institute, and the Institute of Cybernetics.

Activities for 2010

The main 2010 activities include:

- The functionality of the Web site for multiple criteria analysis of discrete alternatives will be extended to support multiple criteria analysis of linear and mixed-integer models. One of the foreseen applications will be analysis of the MESSAGE model to be carried out in collaboration with the ENE Program.
- In collaboration with the LUC, APD, and FOR programs a new mechanism for cost-efficient and environmentally safe emission trading will be implemented as a Web-enabled application.
- The EU-funded EnRiMa project will start in fall. IME will contribute methods, expertise, and tools in stochastic programming, non-smooth optimization, robust solutions, and Web-enabled modular applications for model-based decision-making support.
- New approaches for security analysis under endogenous uncertainty will be advanced. Modeling robust solutions for food, water, energy and environmental security will be conducted in collaboration with the LUC Program and institutes of the Ukrainian National Academy of Sciences.

Personnel Resources

Scientific Staff

Marek Makowski (Poland), Project Leader
Yuri Ermoliev (Ukraine)
Sjur Flam (Norway)
Janusz Granat (Poland)
Shuo Liu (China)
Hongtao Ren (China)
Masatoshi Sakawa (Japan)
Jacek Wojciechowski (Poland)

YSSP

Muhammad Asif (Pakistan)
Oleksandra Borodina (Ukraine)
Tomoko Hasegawa (Japan)
Luciana Kindl da Cunha (Brazil)
Eduardo Maeda (Brazil)

Administrative Support

Amalia Priyatna (Indonesia)
Suchitra Subramanian (India)

Publications[1]

Journal Articles

Ermoliev Y, Ermolieva T, Fischer G & Makowski M (2009). Extreme events, discounting and stochastic optimization. *Annals of Operations Research*, Article in press (Published online 17 September 2009). [LUC]*

Fischer G, Ermolieva T, Ermoliev Y & Sun L (2009). Risk-adjusted approaches for planning sustainable agricultural development. *Stochastic Environmental Research and Risk Assessment*, 23(4):441-450 (May 2009). [LUC]*

Flam SD & Ermoliev Y (2009). Investment, uncertainty, and production games. *Environment and Development Economics*, 14:51-66 (February 2009).*

Makowski M (2009). Management of attainable tradeoffs between conflicting goals. *Journal of Computers*, 4(10):1033-1042 (October 2009).*

Book Chapters

Ermoliev Y (2009). Stochastic quasigradient methods in minimax problems. In: Floudas CA & Pardalos PM (eds), *Encyclopedia of Optimization*. Springer-Verlag, New York, USA, pp. 3813-3818.*

Ermoliev Y (2009). Stochastic quasigradient methods: Applications. In: Floudas CA & Pardalos PM (eds), *Encyclopedia of Optimization*. Springer-Verlag, New York, USA, pp. 3807-3813.*

Ermoliev Y (2009). Stochastic quasigradient methods. In: Floudas CA & Pardalos PM (eds), *Encyclopedia of Optimization*. Springer-Verlag, New York, USA, pp. 3801-3807.*

Ermoliev Y (2009). Two-stage stochastic programming: Quasigradient method. In: Floudas CA & Pardalos PM (eds), *Encyclopedia of Optimization*. Springer-Verlag, New York, USA, pp. 3955-3959.*

1 *) Peer Reviewed
Highlighted publications appear more than once in the IIASA Publications List:
Dark brown entries: IIASA author collaborated with IIASA colleagues from different IIASA programs, identified in brackets.
Light brown entries: IIASA author researches for more than one IIASA program, identified in brackets.

Ermolieva T, Ermoliev Y, Fischer G & Makowski M (2009). 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, pp. 45-68. [LUC]*

Ermolieva T, Makowski M, Fischer G & Ermoliev Y (2009). Economic evaluation of dams for flood protection: An integrated safety approach. In: de Wrachien D & Mambretti S (eds), *Dam-break Problems, Solutions and Case Studies*. WIT Press, Southampton, UK, pp. 241-272. [LUC]*

Other Publications

Ermoliev Y, Ermolieva T & Makowski M (2009). Effective coping with uncertainties in evaluation of the compliance to international treaties (Abstract). In: *ISS09 Book of Abstracts*, International Scientific Studies Conference, 10-12 June 2009, Hofburg, Vienna, Austria, p. 133. [GGI, LUC]

Ermolieva T, Ermoliev Y, Fischer G, Jonas M, Makowski M & Wagner F (2009). Carbon emissions trading and carbon taxes under uncertainties (Abstract). In: *CwU'2009: IIASA/GAMM Workshop on Coping with Uncertainty: Managing Safety of Heterogeneous Systems – Abstracts*, 14-16 December 2009, IIASA, Laxenburg, Austria, p. 9. [APD, FOR, LUC]

Schenler W, Hirschberg S, Burgherr P, Makowski M & Granat J (2009). Final Report on Sustainability Assessment of Advanced Electricity Supply Options. Deliverable D10.2-RS2b, NEEDS (New Energy Externalities Development for Sustainability).

Conference Proceedings

Liu S, Han L, Ermoliev Y & Ermolieva T (2009). Catastrophe bond pricing based on behavior model. In: Ma H & Narayanan S (eds), *Proceedings of the IASTED International Conference on Modelling, Simulation, and Identification*. MSI 2009, 12-14 October 2009, Beijing, China. [GGI, LUC]*

Interim Reports

Asif M (2009). A Virtualized SGE-based Computational Cluster for Heterogeneous Environments. IIASA Interim Report IR-09-052.

Borodina O (2009). Food Security and Socioeconomic Aspects of Sustainable Rural Development in Ukraine. IIASA Interim Report IR-09-053.

Cunha L (2009). Distributed River Basin Modeling for Analyzing Flood Mitigation Measures Under Non Stationary Conditions. IIASA Interim Report IR-09-054.

Granat J & Makowski M (2009). Multicriteria Methodology for the NEEDS Project. IIASA Interim Report IR-09-010.

Granat J, Makowski M & Ogryczak W (2009). Multiple Criteria Analysis of Discrete Alternatives with a Simple Preference Specification: Pairwise-outperformance based Approaches. IIASA Interim Report IR-09-023.

Hasegawa T (2009). An Estimation Method for the Emission Accounting Table of Global Agricultural Activities. IIASA Interim Report IR-09-055.

Maeda E (2009). Impacts of Agricultural Expansion on Irrigation Water Requirements in Taita Hills, Kenya. IIASA Interim Report IR-09-056.

Makowski M, Granat J & Ogryczak W (2009). Overview of Methods Implemented in MCA: Multiple Criteria Analysis of Discrete Alternatives with a Simple Preference Specification. IIASA Interim Report IR-09-024.

Makowski M, Granat J & Ren H (2009). User Guide to MCA: Multiple Criteria Analysis of Discrete Alternatives with a Simple Preference Specification. IIASA Interim Report IR-09-022.

Makowski M, Granat J, Ren H, Schenler W & Hirschberg S (2009). Requirement Analysis and Implementation of Multicriteria Analysis in the NEEDS Project. IIASA Interim Report IR-09-009.

Sakawa M & Kato K (2009). Fuzzy Random Noncooperative Two-level Linear Programming through Absolute Deviation Minimization Using Possibility and Necessity. IIASA Interim Report IR-09-021.

Sakawa M & Kato K (2009). Interactive Fuzzy Programming for Stochastic Two-level Linear Programming Problems through Probability Maximization. IIASA Interim Report IR-09-013.

Sakawa M & Kato K (2009). Interactive Fuzzy Random Two-level Linear Programming through Fractile Criterion Optimization. IIASA Interim Report IR-09-020.

Sakawa M & Kato K (2009). An Interactive Fuzzy Satisficing Method for Multiobjective Nonlinear Integer Programming Problems with Block-angular Structures through Genetic Algorithms with Decomposition Procedures. IIASA Interim Report IR-09-014.

Scientific recognition

- Yuri Ermoliev was invited to give a keynote lecture on "New challenges in stochastic optimization" at a special session of the annual International Conference on Problems of Decision Making under Uncertainties, organized in cooperation with IIASA by a network of leading Ukrainian universities and institutes.
- Yuri Ermoliev has been invited to contribute four articles to the new edition of *Encyclopedia of Optimization* summarizing state-of-the-art of stochastic quasi-gradient methods as well as two-stage stochastic programming, minimax models, and their applications.
- Marek Makowski was invited to the Program Committees of two conferences: The IFIP (International Federation of Information Processing) WG 7.6, co-organized by the Naval Postgraduate School, Monterey, USA, where he gave lecture and an online demonstration of "Web-based Multiple Criteria Analysis: Needs, Architecture, Implementation, and Decision Support in Telecommunications, " organized by Coimbra University, Portugal, where he presented paper on "Multiple criteria analysis made easy yet effective."
- Yuri Ermoliev and Marek Makowski were invited to the International Scientific Studies Conference organized by the CTBTO. The invited lecture on "Global environmental problems: Negotiating integrity of international goals" was prepared in collaboration with Tatiana Ermolieva of the LUC Program.
- IME was invited by the Indian NMO to co-organize the Training Workshop on Mathematical Modeling. For five days, 30 participants from 16 different Indian organizations attended lectures and discussions on methodology of mathematical modeling and applications of modern methods in the areas of environment, the economy, and policymaking. The workshop included hands-on sessions using the IME Web site for interactive multi-criteria analysis.

External Research Contracts above €10,000

Title	Funder	Date From	Date To	Total (€)	2009 (€)
NEEDS New Energy Externalities Developments for Sustainability	European Commission, DG Research via Istituto di Studi per l'integrazione dei Sistemi	01.09.2004	28.02.2009	133,797	54,668

Part V

Cross-Cutting Activities

Greenhouse Gas Initiative

Anthony Patt
patt@iiasa.ac.at

Objectives

The Greenhouse Gas Initiative is the largest-ever inter-program collaborative research effort at IIASA, involving more than two dozen researchers from eight IIASA Programs. It 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 to stabilize atmospheric concentrations of greenhouse gases in order to avoid dangerous impacts. However, GGI now also emphasizes the need for regional approaches that address mitigation or adaptation, as well as sustainable development.

Scientific Achievements

In 2009 GGI continued to explore several interesting climate-change-related research questions in interdisciplinary projects, each of which required input from more than one IIASA research program. Specifically, research activities included the continuation of a modeling exercise to assess the co-benefits of integrated nitrogen management with greenhouse gas mitigation and adaptation to climate change; an assessment of investment strategies into mitigation technologies under uncertainty; the continuation of an analysis of policy pathways to human development and implications for GHG emissions; and a project that explored the role of aerosol forcings in climate mitigation scenarios.

In describing the scientific and policy impacts of GGI, it is important to consider what GGI is, and what GGI is not, in comparison with other IIASA research programs. In 2009 as in 2008, GGI funded a set of narrowly defined research projects. It did so by paying for the time of IIASA researchers—each of whom were primarily embedded in and paid for by their respective program—for one or months with that time being directly accountable to the GGI-funded research. GGI did not fund researchers for time associated with other activities, such as policy outreach and project development, as this is the area of IIASA program competence. Moreover, unlike externally funded projects embedded in the research programs, GGI projects did not have a "client" in the policy sector. Hence, the impacts of GGI activities are mainly limited to scientific impacts, while any policy impacts are indirect, occurring where policymakers recognized and adopted the scientific results from GGI research. Where this has happened, we list it with the particular scientific impacts.

Integrated Nitrogen Management in China – INMIC

Feeding the growing Chinese population with higher quality food and a larger share of meat in diets can be accomplished only through increasing agricultural productivity, which is usually achieved through a higher input of nitrogen to soils. This leads to nitrate leaching, which affects the quality of drinking water, to ammonia emissions, which contribute to the formation of atmospheric particles that are harmful to human health, and the release of nitrous oxide (N_2O), an important global greenhouse gas.

This is the topic of an integrated perspective set up as a project within IIASA's GGI, taking up contributions from APD, LUC and FOR. Results from this study reveal multiple benefits of measures for economic development, the local environment, and globally active greenhouse gas emissions. The study estimates for the case of China that an integrated nitrogen management approach could increase agricultural production by up to 50 percent while keeping current levels of nitrogen discharge to soil, water and air at the local scale. Compared to the business-as-usual case, emissions of N_2O greenhouse gas emissions would be 25 percent lower.

For 2009 a modest extension of the INMIC project was granted for the purpose of dissemination, based on the results and concepts mostly obtained during 2008. As a consequence, an IIASA interim report, a peer-reviewed journal publication, and three conference papers have been produced. The publication of project results in the summer 2009 issue of IIASA's Options magazine attracted the attention of the United Nations Environment Programme (UNEP) which requested permission to publish an INMIC graphic in its Year Book 2010.

Climate Risk Management Modeling

This aim of this project was to analyze the importance of biomass-based power generation technologies under socioeconomic and climate uncertainties. The first approach taken was to produce robust portfolios with the Forestry (FOR) portfolio model that could then be compared with the energy mix computed by MESSAGE, as in, for example, Krey and Riahi (2009) with the purpose of cross-verifying the models and also investigating the impact of the aggregation level on results. However, the results were not easy to obtain and, in addition, turned out not to be comparable.

The FOR approach is based on the minimization of the ß-Conditional Value-at-Risk (ß-CVaR), which is the expected loss beyond the ßth percentile of the distribution under consideration, subject to a constraint on expected returns, costs, or profits (or vice versa). The return, cost, or profit distributions are derived by means of a real options model, which finds the optimal timing of investments and operations at the plant level. In this way, a large investor, who wants to diversify across different types of power plant, assumes that plant-level decisions are optimal and decides on a distribution of funds across the different options. In the project, the basic framework was extended to account for robustness in the sense that the best strategy would always be picked, where best means optimal, even if the worst circumstances (in terms of socioeconomic scenarios and/or emissions stabilization targets) materialized. This was achieved by introducing a minimax function as an objective and computing the portfolio optimal across different scenarios.

The FOR portfolio approach, also known as minimization of the ß-Conditional Value-at-Risk was then applied to the GGI scenarios, focusing on the role of biomass with carbon capture. In addition, there was collaboration with a FOR participant in the Young Scientists Summer Program on portfolios of policies (different types of R&D financing, support for negative emission technologies, abatement, etc). The question here was how such a portfolio of policies would evolve dynamically if technology outcomes from the R&D process are uncertain and the policymaker is averse to surpassing a temperature threshold. New temperature distributions were developed by the summer student during his stay at IIASA. Particular attention was paid to comparing situations where negative emission technologies such as biomass-based energy with carbon capture was available and those where they were not in order to determine their importance.

These studies resulted in a total of three papers. Two of those use the new minimax approach and the new GGI scenarios. The first one was accepted for oral presentation at a conference at St. Gallen University in Switzerland in February 2010. The papers will be considered for publication in a special issue of Energy Policy. Similarly, the second paper, which was an extension in the sense that it explored also the temporal dimension of portfolio selection, was accepted at the International Conference for Applied Energy, to be held in Singapore in April 2010. The option is to publish the paper in a special issue of Applied Energy. The third paper on policy portfolios is about to be submitted to either the Energy Journal or Energy Economics; the results were presented in the GGI seminar series.

Policy Pathways to Human Development and Implications for GHG emissions

This project continued from 2008 and addresses the question as to how marginal investments in different public sectors (education, health, energy access, water infrastructure) could affect the level of development in India by the year 2030, as measured in the Human Development Index (HDI). Conversely, with different development pathways leading to the same HDI level, this project also aims to compare the greenhouse gas emissions resulting from these scenarios, potentially identifying alternative pathways with lower emissions. In 2009 progress was made in establishing the linkage between IIASA's work on energy access in India and the air pollution assessment tool GAINS. This allows us to directly assess the effects of energy access policies on air quality and associated problems for human health. First estimates of these effects are now available. The education costing model was calibrated and test runs were performed. Progress was also made on calibrating a micro-simulation model for India that would be used to estimate the overall effect of investment decisions.

Overall progress toward integrating all results into the micro-simulation framework and to finish the project unfortunately could not be done as planned because of sickness of key IIASA staff involved in this project. It is anticipated that the project can be concluded in the course of 2010.

Geoengineering to Avoid Overshoot: An Uncertainty Analysis

A call for geoengineering (or climate engineering) research using stratospheric sulfur injections has been made (Crutzen, 2006) in case there is an urgent need to halt global warming once other mitigation efforts have been exhausted. Although there are a number of concerns over this idea (e.g. Robock, 2008), it is still useful to consider geoengineering as a possible method for limiting warming caused by overshoot. Overshoot is a temporary feature that appears in low stabilizations scenarios aiming for a stringent target (Rao et al., 2008) and could cause sustained warming for decades because of the inertia of the climate system.

The key research question in this study is: If stratospheric sulfur injections were to be used as a "last resort" to avoid overshoot, what would be the suitable start year and injection profile of such an intervention? The study builds upon Wigley's premise of the combined mitigation/geoengineering approach. We investigated the sensitivity of the global-mean temperature projection to: 1) climate uncertainties (climate sensitivity, tropospheric aerosol forcing, and ocean diffusivity); 2) mitigation scenarios including overshoot; and 3) the start year and magnitude of geoengineering intervention.

The project involved researchers from PCC, RAV, ENE, and APD and used a variety of modeling tools available at IIASA: the simple climate model ACC2, which includes an inversion setup that allows for the exploration of parameter interdependency; the MESSAGE model for developing long-term scenarios; and the GAINS model , which allowed a detailed assessment of future aerosol emissions.

For this project we started with a range of overshoot scenarios. "Optimal" injection profiles (start year and magnitude) for capping temperature rise at 2°C were then calculated for each of these mitigation scenarios. The sensitivity of such results to the uncertain parameters were then examined; in particular, we account for the interdependency of the estimates of these parameters such that they are consistent with historical observations (e.g., temperature records) by using an inverse estimation approach.

Unfortunately, the scenario work could not be finished by the end of 2009. However, two research articles are under preparation and the drafts will be finalized in early 2010. One of these has been accepted for presentation at the European Geophysical Union conference in April.

Assessing Adaptation Strategies for Extreme Climate Risks

This project started in 2008 addressed 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 states in bordering India and Nepal, these interrelated questions were investigated for the agricultural sector that is already facing high risks from weather extremes.

The work involved several tasks. One was primarily empirical in nature, quantifying relationships between various direct and indirect adaptation measures and disaster losses.

The core of the project focused on the development of a quantitative economic model, which integrates disaster risk and climate change as well as relevant response options into a microeconomic, livelihood-based model. The modeling framework has been further developed and a paper is under final revisions and submission to Natural Hazards. The modeling involved further extending and refining of the CATSIM-MICRO model for assessing the costs and benefits of adaptation of farming households to natural hazards under additional climate change stress for the case of Uttar Pradesh in Northern India. The CATSIM framework is organized around a stochastic representation of the long-term economic welfare of a single household, based on a cycle of income (in terms of crop production), consumption (considering minimal caloric needs), debt, savings, and income-enhancing investment. The model as currently set up is able, through convolution, to simulate the combined probabilistic shocks of both floods and droughts. Projected climate change impacts on these hazards, as estimated through a statistical downscaling model, have also been incorporated. A key objective of this GGI project was to better represent the role of education and demographic information into the model framework, which has been done with the help of POP and WPP collaborators. Overall, we are finding that disasters have the potential to trap farmers in poverty through their impact on livelihoods. Development assistance in the form of deliberate disaster risk management can return important benefits in terms of helping farmers escape the poverty trap. Finally, integrated physical (e.g., irrigation) and financial (e.g., insurance) intervention packages return higher benefits at similar costs, if interventions for higher (irrigation) and lower frequency events (insurance) are effectively combined. As a consequence, it seems very important to promote the exploration of such integrated packages in a process involving public and private actors.

Based on project findings, RAV scientists Reinhard Mechler and Daniel Kull provided important input to a workshop on "Strategic Tools for Disaster and Climate Risk Management," held at the National Institute of Disaster Management (NIDM), Ministry of Home Affairs in Delhi from 3 to 4 February 2009. The workshop brought together policymakers, experts, civil society groups, bilateral, and multilateral organizations and donors from Nepal, Pakistan, and Europe to discuss strategic tools for disaster and climate risk management. The meeting closed with a high level roundtable composed of members of the planning commission and several secretaries of ministries. Importantly, findings of this project were also made use of for the UN/World Bank study on the Economics of Disaster Risk Management, which will appear early 2010.

As part of the project, Anthony Patt also conducted an empirical analysis into the drivers of disaster risk, comparing factors associated with socioeconomic development with those associated with climate change. He linked this with an ongoing RAV project examining vulnerability drivers in Mozambique (see *Figure 1*). Pulling the two together led to the development of scenarios for the country of Mozambique, and a sample of 23 least-developed countries more generally. The results appeared in the 26 January 2010 issue of Proceedings of the National Academy of Sciences. (Figure 2). They also fed into a consulting project that Anthony Patt conducted with the World Bank, as part of the Bank's 2009 project Economics of Adaptation to Climate Change.

Publications

It is difficult to identify the number of publications that can or should be attributed to GGI researchers, simply because every GGI researcher is active mainly in his or her main research program, and one would not want to double count. We list, in the ANNEX, eleven papers that we can directly trace back to GGI-funded research. Of these, three are published or forthcoming

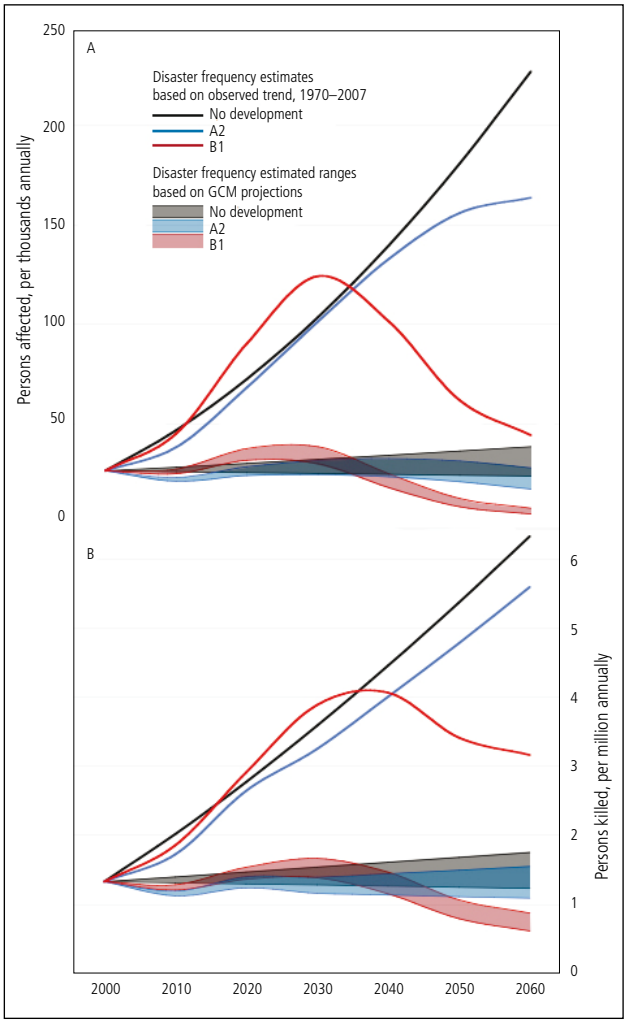


Figure 1. Mozambique risk scenarios to 2060. (A) Expected numbers of people affected (i.e., needing emergency or recovery assistance), by floods, droughts, and cyclones in Mozambique. (B) Expected number of people killed. *Source:* Estimating least-developed countries' vulnerability to climate-related extreme events over the next 50 years, Anthony G. Patt, Mark Tadross, Patrick Nussbaumer, Kwabena Asante, Marc Metzger, Jose Rafael, Anne Goujon, and Geoff Brundrit (2010).

from peer-reviewed journals, and five were presented at international conferences or workshops.

Other Activities

Again, GGI does not fund other activities of IIASA scientists, and hence these are more rightly associated with the researchers' primary programs. For example, Reinhard Mechler is serving as a Lead Author on the Intergovernmental Panel on Climate Change, for their upcoming special report on extreme events. Fabian Wagner has been invited to the editorial board of Carbon Management. Anthony Patt continues on the editorial board of Global Environmental Change, and was in 2009 a founding editor of the new journal, Climate and Development. These activities are listed primarily in the progress reports of the APD and RAV programs.

Activities for 2010

In 2010 GGI will initiate a small number of collaborative research projects that will prepare cross-cutting activities under the 2011–2015 research plan. To this end GGI has made an IIASA internal call for proposals. At the time of writing, six proposals had been submitted for the call, of which GGI plans to fund at least 2 to 4.

Personnel Resources

Initiative Co-Leaders

Hannes Böttcher (Germany)
Samir K.C. (Nepal)
Forrest MacKellar (USA)
Reinhard Mechler (Germany)
Shonali Pachauri (India)
Anthony Patt (USA)
Georg Pflug (Austria)
Fabian Wagner (Germany)

Scientific Staff

Joanne Bayer (USA)
Cheol Hung Cho (Korea, Republic of)
Tatiana Ermolieva (Austria)
Günther Fischer (Austria)
Anne Goujon (France)
Stefan Hochrainer (Austria)
Zbigniew Klimont (Poland)
Volker Krey (Germany)
Daniel Kull (USA)
Wolfgang Lutz (Austria)
Michael Obersteiner (Austria)
Sylvia Prieler (Austria)
Pallav Purohit (India)
Keywan Riahi (Austria)
Elena Rovenskaya (Russia)
Warren Sanderson (USA)
Wolfgang Schöpp (Austria)
David Wiberg (USA)
Wilfried Winiwarter (Austria)
Geza Toth (Hungary), Program Officer

Postdoctoral Research Scholars

Jason Blackstock (Canada)
Christopher Doll (United Kingdom)
Katsumasa Tanaka (Japan)

YSSP

Zoe Chafe (USA), co-supervised with ENE
Lin Fan (China)

Publications[1]

Journal Articles

Hochrainer S, Mechler R & Pflug GC (2009). Climate change and financial adaptation in Africa: Investigating the impact of climate change on the robustness of index-based microinsurance in Malawi. *Mitigation and Adaptation Strategies for Global Change*, 14(3):231-250 (March 2009). [RAV]*

Koch D, Schulz M, Kinne S & Klimont Z et al (2009). Evaluation of black carbon estimations in global aerosol models. *Atmospheric Chemistry and Physics*, 9(22):9001-9026 (27 November 2009). [APD]*

Komendantova N, Patt A, Barras L & Battaglini A (2009). Perception of risks in renewable energy projects: The case of concentrated solar power in North Africa. *Energy Policy*, Article in press (Published online 31 December 2009). [RAV]*

1 *) Peer Reviewed
Highlighted publications appear more than once in the IIASA Publications List:
Dark brown entries: IIASA author collaborated with IIASA colleagues from different IIASA programs, identified in brackets.
Light brown entries: IIASA author researches for more than one IIASA program, identified in brackets..

Krey V, Canadell JG, Nakicenovic N, Abe Y, Andruleit H, Archer D, Grubler A, Hamilton NTM, Johnson A, Kostov V, Lamarque J-F, Langhorne N, Nisbet EG, O'Neill BC, Riahi K, Riedel M, Wang W & Yakushev V (2009). Gas hydrates: Entrance to a methane age or climate threat? *Environmental Research Letters*, 4(3):034007 (7 September 2009). [ENE, PCC, TNT]*

Marland G, Hamal K & Jonas M (2009). How uncertain are estimates of CO_2 emissions? *Journal of Industrial Ecology*, 13(1):4-7 (February 2009). [FOR]*

Mosier AR, Crutzen PJ, Smith KA & Winiwarter W (2009). Nitrous oxide's impact on net greenhouse gas savings from biofuels: life-cycle analysis comparison. *International Journal of Biotechnology,* 11(1-2):60-74 (September 2009). [APD]*

Nelson RG, Hellwinckel CM, Brandt CC, West TO, De La Torre Ugarte DG & Marland G (2009). Energy use and carbon dioxide emissions from cropland production in United States, 1990-2004. *Journal of Environmental Quality*, 38(2):418-425 (March–April 2009).*

Patt A, Peterson N, Carter M, Velez M, Hess U & Suarez P (2009). Making index insurance attractive to farmers. *Mitigation and Adaptation Strategies for Global Change*, 14(8):737-753 (December 2009). [RAV]*

Peters GP, Marland G, Hertwich EG, Saikku L, Rautiainen A & Kauppi PE (2009). Trade, transport, and sinks extend the carbon dioxide responsibility of countries: An editorial essay. *Climatic Change*, 97(3-4):379-388 (December 2009).*

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Prather MJ, Penner JE, Fuglestvedt JS, Kurosawa A, Lowe JA, Hoehne N, Jain AK, Andronova N, Pinguelli L, de Campos CP, Raper SCB, Skeie RB, Stott PA, van Aardenne J & Wagner F (2009). Tracking uncertainties in the causal chain from human activities to climate. *Geophysical Research Letters*, 36(5):L05707 (12 March 2009). [APD]*

Purohit I & Purohit P (2009). Instrumentation error analysis of a paraboloid concentrator type solar cooker. *Energy for Sustainable Development*, 13(4):255-264 (December 2009). [APD]*

Saarnio S, Winiwarter W & Leitao J (2009). Methane release from wetlands and watercourses in Europe. *Atmospheric Environment*, 43(7):1421-1429 (March 2009). [APD]*

Tanaka K, O'Neill BC, Rokityanskiy D, Obersteiner M & Tol RSJ (2009). Evaluating global warming potentials with historical temperature. *Climatic Change*, 96(4):443-466 (October 2009). [FOR, PCC]*

Velthof GL, Oudendag D, Witzke HP, Asman WAH, Klimont Z & Oenema O (2009). Integrated assessment of nitrogen losses from agriculture in EU-27 using MITERRA-EUROPE. *Journal of Environmental Quality*, 38(2):402-417 (March–April 2009). [APD]*

West TO, Marland G, Singh N, Bhaduri BL & Roddy AB (2009). The human carbon budget: An estimate of the spatial distribution of metabolic carbon consumption and release in the United States. *Biogeochemistry*, 94(1):29-41 (May 2009).*

Winiwarter W, Bauer H, Caseiro A & Puxbaum H (2009). Quantifying emissions of primary biological aerosol particle mass in Europe. *Atmospheric Environment*, 43(7):1403-1409 (March 2009). [APD]*

Other Publications

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Ermoliev Y, Ermolieva T & Makowski M (2009). Effective coping with uncertainties in evaluation of the compliance to international treaties (Abstract). In: *ISS09 Book of Abstracts*, International Scientific Studies Conference, 10-12 June 2009, Hofburg, Vienna, Austria, p. 133. [IME, LUC]

Grubler A & Pachauri S (2009). Problems with burden-sharing proposal among one billion high emitters (Letter). *PNAS*, 106(43):E122-E123 (27 October 2009). [PCC, TNT]*

Hochrainer S, Mechler R & Pflug G (2009). Climate change and climate insurance. The case of Malawi (Abstract). *IOP Conference Series: Earth and Environmental Science*, 6(42):422003 (1 February 2009). [RAV]*

Lamarque J-F, Granier C, Bond T, Eyring V, Heil A, Kainuma M, Lee D, Liousse C, Mieville A, Riahi K, Schultz M, Smith S, Stehfest E, Stevenson D, Thomson A, Van Aardenne J & Van Vuuren D (2009). Gridded emissions in support of IPCC AR5. IGAC*tivities* (Newsletter of the International Global Atmospheric Chemistry Project), 41:12-18 (May 2009). [ENE, TNT]

Marland G (2009). Carbon accounting of humans in the United States. *Options* (IIASA, Laxenburg, Austria), Winter 2009/2010, p. 23.

Nussbaumer P & Patt A (2009). Climate vulnerability in Mozambique: Current state and outlook into the future (Abstract). *IOP Conference Series: Earth and Environmental Science* 6(41):412035 (1 February 2009). [RAV]*

O'Neill BC, Riahi K & Keppo I (2009). Mitigation implications of mid-century targets that preserve long-term climate policy options (Abstract). *IOP Conference Series: Earth and Environmental Science*, 6(50):502001 (1 February 2009). [ENE, PCC, TNT]*

Patt A, Battaglini A, Komendantova N, Milkoreit M & Lilliestam J (2009). Beyond feasibility: Linking the Mediterranean region's renewable energy resources to Europe – A roadmap for addressing the policy challenges (Abstract). *IOP Conference Series: Earth and Environmental Science*, 6(19):192003 (1 February 2009). [RAV]*

van Vuuren DP, Meinshausen M, Plattner G-K, Riahi K & Nakicenovic N et al (2009). Temperature increase of 21st century mitigation scenarios (Abstract). *IOP Conference Series: Earth and Environmental Science*, 6(49):492012 (1 February 2009). [ENE, TNT]*

Conference Proceedings

Liu S, Han L, Ermoliev Y & Ermolieva T (2009). Catastrophe bond pricing based on behavior model. In: Ma H & Narayanan S (eds), *Proceedings of the IASTED International Conference on Modelling, Simulation, and Identification*. MSI 2009, 12-14 October 2009, Beijing, China. [IME, LUC]*

Interim Reports

Ermolieva T, Winiwarter W, Fischer G, Cao G-Y, Klimont Z, Schoepp W, Li Y & Asman WAH (2009). Integrated Nitrogen Management in China. IIASA Interim Report IR-09-005. [APD, FOR, LUC]

Krey V & Riahi K (2009). Risk Hedging Strategies under Energy System and Climate Policy Uncertainties. IIASA Interim Report IR-09-028. [ENE, TNT]

Part VI

Programs for Young Scientists

Young Scientists Summer Program

Joanne Bayer, Dean
bayer@iiasa.ac.at

In 2009 the acclaimed Young Scientists Summer Program (YSSP) welcomed 53 young scientists from 22 countries to work on their research projects within IIASA research programs. Since the beginning of the YSSP program in 1977, some 1515 participants have benefited from the opportunity of collaborating with IIASA's scholars and enhanced their own perspectives and career opportunities. Many have achieved high positions in science, business and government, while others have returned to IIASA as research scholars or continue to work as close collaborators in the Institute's research network.

The 2009 scientific program was designed to emphasize and expose the critical role and relevance of interdisciplinary science and policy analysis in tackling real-world problems. Four workshops were organized at which selected research programs presented their core research:

- At the first workshop on **The Global Commons**, research staff from the Evolution and Ecology, Forestry, and Land Use Change Programs presented research on the environment and natural resources.
- At a second workshop on **Climate Change**, panel members from the Greenhouse Gas Initiative (GGI), Atmospheric Pollution Program (APD), Energy (ENE), International Negotiations (PIN) and the Risk and Vulnerability (RAV) programs presented research on emissions and development, extreme events, critical infrastructure, and negotiations.
- Panel members from the Dynamic Systems and Integrated Modeling provided an overview of modeling and IIASA in-house modeling tools during the third workshop on **Systems Analysis and Modeling**.
- A workshop on **Human Wellbeing** brought together research staff from the Health and Global Change (HGC), Population, Land Use and RAV Programs to present their work on education and human capital, food security, and human health.

The following external speakers were invited to address the YSSPers:

- Former IIASA Council Chair, Simon Levin spoke about the *Challenge of Sustainability: Lessons from an Evolutionary Perspective*

The 2009 YSSP participants.

- Walter Lichem, former Austrian Ambassador to Chile and Canada discussed the *Need for More Knowledge-Based Global Governance*
- Secretary General of the 1972 Stockholm Conference and 1992 Rio Earth Summit, Maurice Strong, addressed the students about *Crisis and Opportunity—Civilization at the Crossroads*
- Helga Nowotny, Vice President of the European Research Council chose the topic *Out of Science – Out of Sync*, and finally
- Ed Mortimer, Chief Program Officer of the Salzburg Seminar and former Foreign Affairs Commentator of the Financial Times looked at *Communicating the Global Agenda to the Public*

Peccei Awards went to Zachary Brown for research on malaria control portfolios carried out during his YSSP affiliation with the Health and Global Change Project and to Gregor Kiesewetter for his work undertaken in the APD Program on assessing transport of particulate matter pollution from Europe to the Arctic.

Winner of the Mikhalevich Award was Christian Hilbe who was recognized for his work on public-goods games under time pressure in the Evolution and Ecology Program.

Postdoctoral Program

Barbara Hauser, Coordinator
hauser@iiasa.ac.at

Postdoctoral research opportunities continued at IIASA during 2009.

Upasna Sharma and Jose Siri received the two 2009 IIASA-funded postdoctoral positions. Sharma holds a PhD in public policy and climate change from the School of Management at the Indian Institute of Technology, Bombay. She is hosted by the RAV program where she is researching issues related to communication of uncertainty associated with climate forecasts and climate hazard warnings, particularly, how the target audience of these forecasts and warnings interpret and understand uncertainty.

Jose Siri joined the HGC project to do research on how urbanization patterns and urban structure affect the transmission of mosquito-borne disease, and how better understanding of the dispersal of humans, vectors, and infection in this context can lead to more effective and efficient public health policy. He received his PhD in Epidemiology (2006) from the University of Michigan

Terence Fell, Erling Lundevaller, and Johan Östergren continued their postdoctoral research in 2009 under the sponsorship of the Swedish Kempe Foundation.

Part VII

Appendices

Communications

Iain Stewart
stewart@iiasa.ac.at

Objectives

IIASA's Communications (COM) Department aims to help position IIASA as a leading global research organization dealing with environmental, economic, technological, and social change by:

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.

Selected Highlights of 2009

- **COM's output increased** according to several indicators: 6 IIASA Policy Briefs (2 in 2008, 2 in 2007), 13 media releases (10 in 2008, 4 in 2007), 63% of publications in IIASA Publications catalog are available online (43% in 2007, 10% in 2005), 3 IIASA books published (0 in 2008, 2 in 2007), 4 sections of IIASA's Web site redesigned (1 in 2008).
- **COM initiated several new activities:** IIASA E-Newsletter was launched in October and now has 2,100 subscribers. An NMO fact sheet was tested with NMOs with very positive feedback. Increasing IIASA's presence at a major international event with an exhibit at COP15 attracted several thousand visitors and over 400 subscribers for IIASA's material.
- **The impact of COM's work increased:** IIASA's media coverage has increased 2.5- fold from approximately 400 media hits in 2008 to approximately 1,000 in 2009. Readership of many IIASA publications continued to increase with the circulation of Options reaching over 6,500; IIASA Annual Report over 3,300; PINPoints over 3,200; and POPNET over 2,800. IIASA Policy Briefs have increased in popularity with the six briefs published in 2009 circulated to over 8,000 recipients. Unique visitors to IIASA's Web site increased to 80,525 in 2009 (74,492 in 2008, 71,231 in 2007).
- **Support for communication activities of IIASA scientists was wide-ranging** and included posters, a brochure, and publication covers for EEP; introductory video to the GAINS Mitigations Efforts Calculator; communication support for IIASA as co-organizer of the International Energy Conference in Vienna; redesigning APD Web site; language editing of journal articles and reports; a package of YSSP branded material; presentations for the Director; and general communication advice to researchers.

Summary of COM Outputs and Support in 2009

NMOs: To raise awareness of and support for IIASA among NMOs, COM produced and distributed to NMOs:

- The Annual Report 2008, the Progress Report 2008, IIASA's New Strategic Plan publication, Options (Summer and Winter issues), IIASA electronic newsletter, press releases, reports on IIASA's media coverage, packages of IIASA communication materials (e.g., YSSP flyer and posters, Postdoc flyer and posters, IEF flyer), various IIASA publications, the first in a series of information factsheets for NMOs.

Scientific community: To raise awareness of and recognition for IIASA's research, teams of scientists, and capacity building programs; COM produced and distributed to targeted lists of scientists:

- Three IIASA books in association with Springer (Negotiated Risks [PIN], Technological Innovation across Nations [Watanabe], Managing Innovation in Japan [Watanabe]); a fourth IIASA book (Elements of Adaptive Dynamics [EEP]) is in production;
- Two IIASA Research Reports (Lung Health in Rural Nepal [POP], Uncertainty and Disaster Risk Management [RAV]); 34 IIASA Interim Reports; 2 IIASA Reprints; Options; four newsletters (e-newsletter, PinPoints [x2], POPNET);
- Produced a package of branded material for YSSPers including the handbook: YSSP calendar, directory, YSSP certificates, material for YSSP Awards Dinner;
- Redesigned the APD web site;
- Updated and maintained IIASA's Publication Catalog (8,959 publications); and
- Managed permission requests for the use of IIASA copyrighted material.

Policymakers and diplomatic community: To raise awareness of IIASA as a reliable source of high-quality, neutral research on international issues. Activities included:

- Supported (science) and lead (exhibit) co-ordination of IIASA's representation at COP15; worked with UNIDO on the communications for the International Energy Conference in Vienna;
- Produced and distributed 6 IIASA policy briefs;
- Built relationships with communication teams in relevant national and international organizations (e.g. United Nations Communications Group);

All other audiences including general public and media: To raise awareness of IIASA.

- Options; 13 media releases; 4 media alerts; IEF flyer; 4 podcasts; e-newsletter;
- Development of IIASA's Web site: redesigning 4 sections, adding disclaimer pages, and preparing for the redesign (establishing a web site committee, 5 focus groups with Web users, and preparing mock ups for new front page)

Supporting the communication activities of IIASA scientists and encouraging communication

- Ongoing support includes: English language editing, science writing, graphic design, publication production, print service, maintaining mailing lists, professionally managing IIASA's Web site, running a proactive and reactive press office, supporting various communication activities of the Director, and advising scientists on communication strategy and providing specialized support to implement communication tactics from podcasts to media training.
- New front page Web site policy and a new IIASA brand policy

2009 Scientific Meetings, Sponsored or Co-sponsored by IIASA

Meeting of Members of the Advisory Council of the German Government on Global Change (WBGU)
May 14–15
Transitions to New Technologies

Energy Use & Emissions in a Co-Benefits World Workshop I "HarmonE": Today's Technology, Tomorrow's Drivers
May 18–19
Atmospheric Pollution and Economic Development

Energy Use & Emissions in a Co-Benefits World Workshop II
Joint ACCENT/UC Berkeley Workshop on Household Energy: Household Energy Database
May 20–22
Atmospheric Pollution and Economic Development

Workshop on Comparisons of GHG Mitigation Costs
May 28–29
Atmospheric Pollution and Economic Development

RAV-ACRP Meeting
June 02
Risk and Vulnerability

Meeting of the Permanent Delegation of Sweden to the OSCE in Vienna
June 05
Directorate

Council Meeting
June 08–09
Directorate

NMO DAY
June 10
Directorate

KOSEF-IIASA Meeting
June 11
Directorate

US NMO Committee Meeting
June 11
Directorate

MCPFE Peer Review Meeting
June 11-12
Forestry

CTBT Negotiation Workshop
June 13–14
Processes of International Negotiation

PIN Climate Change Simulation Game
June 14–16 (held in Manila, Philippines)
Processes of International Negotiation

Global Energy Assessment Lead Author Scoping Meeting
June 19–20 (held in Vienna, Austria)
Global Energy Assessment

Towards an Integrated Energy Agenda Beyond 2020
June 22–24 (held in Vienna, Austria)
Global Energy Assessment

Conference on Technological Change and Global Warming
August 04–05 (held in Snowmass, CO, USA)
Transitions to New Technologies

CSM'2009 – The 22nd Workshop on Complex Systems Modeling
August 31–September 02
Integrated Modeling Environment

Retreat on the Strategic Plan Implementation
September 02
Directorate

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

Evolution of Cooperation - Models and Theories
September 15–18
Evolution and Ecology

Integrated Assessment Modeling Consortium (IAMC) Meeting
September 15–16 (held in Tsukuba, Japan)
Energy

Extreme Events in Human Society Workshop
September 17–18
Dynamic Systems

The IIASA Koopmans Lecture by Professor Thomas C. Schelling on Institutions Needed for Climate Management
September 18
Directorate

SafeLand Workpackage 5.2 Meeting
September 28–29
Risk and Vulnerability

Global Energy Assessment Knowledge Module (24) Working Group Meeting on Innovation
October 01–03 (held in Lund, Sweden)
Global Energy Assessment

IN-Stream Project Meeting
October 01–02
Land Use Change and Agriculture

LIFE III - EC4MACS Project Meeting
October 05
Atmospheric Pollution and Economic Development

36th Meeting of the UN/ECE Task Force on Integrated Assessment Modelling
October 06–07
Atmospheric Pollution and Economic Development

Study visit of the Swedish Delegation
October 06
Directorate

9th IIASA-DPRI Forum on Integrated Disaster Risk Management
October 12–16 (held in Kyoto, Japan)
Risk and Vulnerability

Global Energy Assessment Knowledge Module (18) Working Group Meeting on Urbanization
October 12-14
Global Energy Assessment

CC-TAME Annual Meeting 2009
October 12–13
Forestry

CityZen 1st Annual Meeting
October 13–16
Atmospheric Pollution and Economic Development

Virtual SAC meeting
October 16
Directorate

Evaluation Committee Meeting on Energy and Technology
October 23–25
Directorate

Council Meeting
November 02–03
Directorate

PIN Steering Committee Meeting
November 04–05 (held in Ottawa, Canada)
Processes of International Negotiation

PIN Roadshow Ottawa – Mediating Identity Conflicts. An International Negotiation Workshop
November 06–07 (held in Ottawa, Canada)
Processes of International Negotiation

Global Energy Assessment Executive Committee
November 22–25
Global Energy Assessment

International Conference on Education and Demography
November 30 – December 01 (held in Vienna, Austria)
World Population

Chinese Forest Sector Modeling Workshop
November 30 – December 03
Forestry

COP 15 Brainstorming Session for the Global Energy Assessment
December 01 (held in Washington, DC, USA)
Global Energy Assessment

COP – United Nations Climate Change Conference
December 11 (held in Copenhagen, Denmark)
Directorate

PIN Editorial Meeting (CTBT book)
December 10 (held in London, United Kingdom)
Processes of International Negotiation

Global Energy Assessment Knowledge Module 9 Writing Team Meeting
December 10 (held in Copenhagen, Denmark)
Global Energy Assessment

The 3rd IIASA-Tokyotech Workshop on Hybrid Management of Technology in the 21st Century
December 13–14
Dynamic Systems

IIASA/GAMM Workshop on Coping with Uncertainty (CwU) - Managing Safety of Heterogeneous Systems
December 14–16
Integrated Modeling Environment

Global Energy Assessment Event at UN Climate Change Conference COP
December 14 (held in Copenhagen, Denmark)
Global Energy Assessment

Other External Contracts, General Research

Title	Funder	Date From	Date To	Total (€)	2009 (€)
Korean Trust Fund (funds to be used for research collaboration, travel, etc.)	Korea Science and Engineering Foundation (KOSEF)	01.07.2008	31.12.2010	96,277	13,023
Risk Assessment and Risk Management to Improve Preparedness for Extreme Events	University of Southern California (USC)	01.04.2009	28.02.2010	63,635	36,642
Contribution toward participation in WBGU Advisory Board Meeting - Compensation for Nebojsa Nakicenovic	Stiftung Alfred-Wegener-Institut für Polar- und Meeresforschung	01.11.2008	31.12.2009	23,654	23,654
Xevents in Human Society	Fountain Park Inc.	01.10.2009	31.12.2009	18,000	18,000

2009 IIASA Guest Lectures

- 10 December 2009, **Mr. Rohit Talwar**, Fast Future, "The Future of Futures"
- 2 December 2009, **Dr. Paulina Adebusoye**, Nigeria Institute of Social and Economic Research, "Population, Education and Poverty from an African and a Latin American Perspective" (seminar jointly with Eduardo Rios-Neto, Brazil)
- 2 December 2009, **Professor Eduardo Rios-Neto**, Dept. of Demography, UFMG – Universidade Federal de Minas Gerais; FACE – Faculdade de Ciencias Economicas, and Cedeplar (Center for Population and Development), Director of Cedeplar, "Population, Education and Poverty from an African and a Latin American Perspective" (seminar jointly with Paulina Makinwa Adebusoye, Nigeria)
- 24 November 2009, **Prof. Anand Patwardha**n, Shailesh J Mehta School of Management at the Indian Institute of Technology, Bombay, "An Update on the UNFCCC Negotiations and Prospects for the Future"
- 20 November 2009, **Dr. Ugur Bilge**, London School of Economics Complexity Group, Senior Research Associate, "Agent Based Modelling in the Real World"
- 2 October 2009, **Dr. Elaine Matthews**, NASA Goddard Institute for Space Studies, "Historical and Future Methane Emissions; Trends, Drivers and Uncertainties"
- 23 September 2009, **Dr. Chiho Kaito**, Department of Information and Computer Sciences, Nara Women's University, "Spiral Formation through Individual-based Host-parasite Dynamics in Continuous Space"
- 21 September 2009, **Dr. Alex Soojung-Kim Pang**, Institute for the Future, Director, "Future 2.0: Rethinking the Field"
- 11 September 2009, **Prof. Martin Parry**, Grantham Institute and Centre for Environmental Policy, Imperial College London, "Trying to Close the Research Loop between Emissions/Climate Change/Impacts/Adaptation"
- 11 September 2009, **Ms. Vannessa Schweizer**, Department of Engineering & Public Policy, Carnegie Mellon University, "Useful Parsimonious Long-term Energy Projections in the Face of Climate Change"
- 31 August 2009, **Mr. Dennis Meadows**, The Institute for Policy and Social Science Research - University of New Hampshire, Director, "Perspectives on Limits to Growth 37 Years Later"
- 20 August 2009, **Mr. Andrew Nash**, Vienna Transport Strategies, "Bus Meister: A Web 2.0 Application for Improving Public Participation in Transport Planning"
- 14 August 2009, **Dr. Fabrice Murtin**, OECD, Economics Department (SPAD2), Economist, "Education and Economic Development Since 1870: A Global Perspective"
- 7 August 2009, **Prof. Sergey Kryazhimskiy**, Department of Biology, University of Pennsylvania, "Fitness Landscapes and the Dynamics of Adaptation"
- 6 August 2009, **Dr. Daniel Simpson**, Department of Mathematics and Mathematical Statistics, Umea University, "Numerical Investigation of Models in which Asymmetric Competition Effects the Growth Rate"
- 14 July 2009, Dr. Raimund Kovacevic & **Dr. Georg Pflug**, University of Vienna, "Does Insurance Help to Escape from the Poverty Trap?"
- 13 July 2009, **Ambassador Chung-Taek Park**, Korean Embassy/Permanent Mission to the International Organizations in Vienna, "Current Research Status of Energy Policy and Climate Change Including Their Related Science and Technology Policy"
- 9 July 2009, **Prof. Gunnar Sjöstedt**, PIN/Swedish Institute of International Relations, "YSSP Midsummer Meeting"
- 15 June 2009, **Dr. Volker Jentsch**, Interdisziplinares Zentrum fuer Komplexe Systeme, Universitaet Bonn, "Why Study Extreme Events?"
- 11 May 2009, **Prof. Alexei Gvishiani**, Director, Geophysical Center, Russian Academy of Sciences, Moscow, "Anomalies in Time Series and X-events"
- 28 April 2009, **Prof. Stefan Bergheim**, Centre for Societal Progress, Director, "Complementary Aspects of the Progress of Societies"
- 9 April 2009, **Mr. David Holland-Smith**, UK Defence Science and Technology Laboratory, "Science and Technology Horizon Scanning"
- 12 March 2009, **Dr. Henry H. Willis**, RAND Corporation, Policy Researcher, "Challenges of Applying Risk Analysis to Terrorism Security Policy"
- 11 March 2009, **Prof. Stefan Thurner**, Complex Systems Research Group Medizinische Universität Wien, "Why Complex Dynamical Systems Crash"
- 10 March 2009, **Prof. Howard Kunreuther** & **Dr. Erwann Michel Kerjan**, Management and Decision Process Center, Wharton School, University of Pennsylvania, "Long Term Insurance and Climate Change"
- 27 February 2009, **Mr. Markku Wilenius**, Senior Vice President, Allianz SE, "What you incentivize is What you Get; Some Remarks on the (Financial) System that Worked Perfectly Well"
- 24 February 2009, **Dr. Scott Rickard**, School of Electrical, Electronic and Mechanical Engineering, University College Dublin, "Costas Arrays, Source Separation, CASL and Other Extremal Events"
- 23 January 2009, **Prof. Sjur Didrik Flam**, Department of Economics, University of Bergen, Norway, "On Catastrophe Insurance"
- 21 January 2009, **Mr. Anthony Milner**, Oxford University, "Informational Bases of Adaptation to Climate Change"