International Institute for Applied Systems Analysis
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options

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Climate change

Looking beyond Copenhagen

Detlof von Winterfeldt
Director, IIASA

Looking beyond Copenhagen

As I write, it is a month until thousands of climate researchers, politicians, negotiators and representatives of special interest groups descend on Copenhagen to observe the efforts of our world leaders to negotiate a successor to the Kyoto Protocol.

IIASA's researchers will be there as well. Our research suggests that deep cuts in greenhouse gas emissions are needed to limit global warming to less than the 2 °C agreed on at the G8 meeting in L'Aquila, Italy, in July 2009. At the same time, IIASA research has shown that current emission levels fall far short of the pledges; and with every passing year of slow or no action, it will be more difficult to stay below the 2 °C limit. Cost is no excuse: our researchers have found that the cost of greenhouse gas emission reductions is in fact much smaller than previously estimated (see pages 16–17).

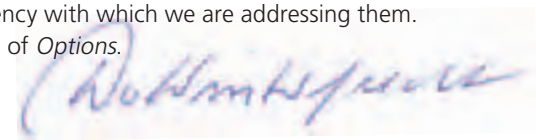
Given past experience it is by no means certain that a legally binding agreement on deep cuts will be reached. From 22 September 2009 when UN Secretary-General Ban Ki-moon declared in New York, "Momentum has shifted for a global deal in Copenhagen," there have been various ups-and-downs and U-turns regarding the likelihood of a binding deal.

So we might not get agreement on the greenhouse gas reduction "numbers" wanted by the UK government; there could be a disappointing "no-show" by U.S. President Barack Obama; and the conflict between developed and developing countries about the "fair share" of responsibilities to reduce greenhouse gas emissions and the aid needed to assist developing countries in this task may linger on.

Many pundits say that a UN meeting in Mexico in December 2010 is now the most likely venue for a treaty to be finalized—the kind of hiatus that happened in the case of the Kyoto Treaty, they add in an attempt to reassure themselves and us. Possibly, those same pundits have forgotten that the Kyoto Protocol, signed in 1998, took a further seven years to enter into force. This time around, we don't have seven years. A firm and courageous implementation schedule is needed to put new climate change mitigation measures in place *soon*.

It has been said that many politicians consider only a short time horizon when making decisions, a tendency that my colleague Howard Kunreuther of the University of Pennsylvania calls NIMTOFF—not in my term of office. In contrast, decisions on climate change require the farsightedness and courage to pay now for actions that have considerably delayed benefits. Researchers at IIASA and elsewhere have taken that farsighted view, studying the costs, risks, and benefits of climate change stretching over many decades to come.

With our new strategic plan (see page 6) we have taken steps to focus our research agenda and make it even more policy relevant. The recently established endowment fund (see back page) will help to maintain the Institute's independence and objectivity You will see from this issue of *Options* the breadth and depth of scientific issues in which IIASA and its partners are involved and the urgency with which we are addressing them. I hope you enjoy reading this issue of *Options*.



About IIASA

IIASA is an international scientific institute that conducts policy-orientated research into problems that are too large or complex to be solved by a single country or academic discipline.

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

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

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

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

Austria, China, Egypt, Finland, Germany, India, Japan, Netherlands, Norway, Pakistan, Poland (observer), Republic of Korea, Russian Federation, South Africa, Sweden, Ukraine, United States of America.

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About *Options*

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contents

The cover shows an optimistic outlook in which the world has embarked on a path to first slow the growth of greenhouse gas emissions and then lower emissions during the twenty-first century. The pathway to avoiding dangerous climate change requires adopting a range of measures, many of which are highlighted in this issue of *Options*.

ELECTRICITY-GENERATING TECHNOLOGIES

Climate policy uncertainty

© Stephen Finn | Dreamstime.com

IIASA researchers, together with colleagues from Sweden and Slovakia, used a dynamic programming model to analyze the transition from CO_2-intensive to CO_2-neutral electricity production in the face of rising and uncertain CO_2 prices. Three typical technologies, based on fossil fuel, fossil fuel with carbon capture, and renewable energy, respectively, were analyzed in the context of uncertainty about regulation, which was modeled through a rising, stochastic CO_2 price.

It was found that greater CO_2 price uncertainty leads to investment in lower-emission technologies being postponed over the coming century and thus higher cumulative CO_2 emissions. This is a real options effect, where larger uncertainty results in a postponement of irreversible decisions, which, in the case of the electricity sector, is an investment involving large sunk costs. The team also found that climate change policies that are adapted less frequently and thus remain stable over a longer period are more conducive to environmentally friendly investment than policies that change more frequently.

The modeling also allowed researchers to estimate the expected value of information by comparing the expected costs of the optimal investment plan under uncertainty with those when the investor has perfect information. This is often called the "willingness to pay" for information (i.e., the amount of money the decision maker would be willing to pay to be able to make a better-informed decision). With increasing CO_2 price uncertainty, the expected value of information would be expected to rise; moreover, less frequent fluctuations also reduced the expected value of information and resulted in smaller cumulative CO_2 emissions.

According to IIASA's Dr. Sabine Fuss: "It is very important for policymakers to understand how their policies influence decision making in the energy sector. The results of the study underline the need for policymakers to make a strong commitment to facilitate optimal investments and an earlier transition to a less carbon-intensive energy mix." ■

Fuss S, Johansson DJA, Szolgayova J, Obersteiner M (2009). Impact of climate policy uncertainty on the adoption of electricity generating technologies. *Energy Policy* 37(2):733–743.

HEAT WAVE–RELATED DEATHS

Climate change prescriptions

Wolfgang Lutz of IIASA's World Population Program, together with physicians from the Rudolfstiftung Hospital, Vienna, Austria, has published a short communication in the *European Journal of Neurology* linking heat wave–related fatalities to the use of certain drugs. Numerous categories of drugs, including thyroid hormones, some antidepressants, and cocaine, impair the body's thermoregulation and suppress thirst.

During the 2003 French heat wave 15,000 excess deaths were registered, one-fifth from a combination of dehydration, heatstroke, and hyperthermia and one-tenth from dehydration, despite abundant water being available.

As a consequence of global climate change, heat waves may occur more frequently and be more intense. The researchers call for greater awareness on the part of medical personnel of the enhanced physiological impact of certain drugs during heat waves, increased public understanding of the dangers, and new long-term strategies to mitigate the expected increase in future heat wave–related fatalities. ■

Stöllberger 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.

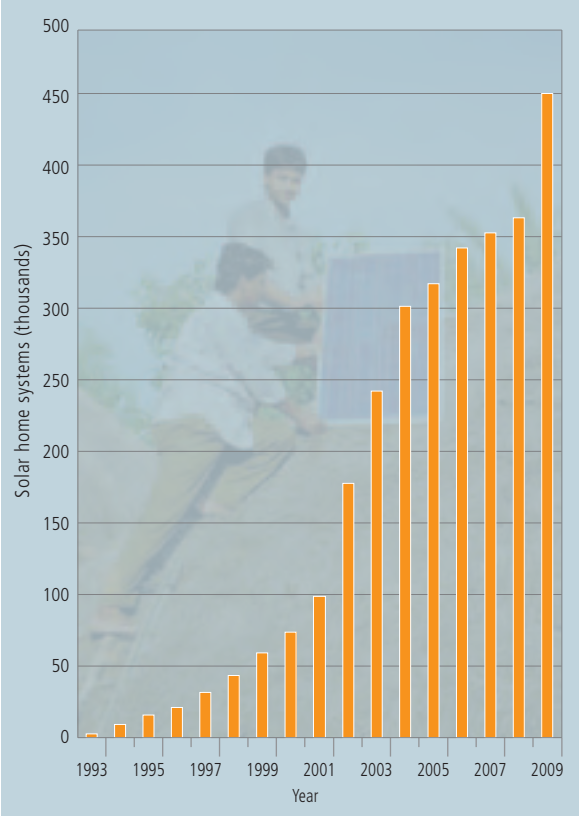
EVOLUTION & ECOLOGY

Food-web stability

Escalating concerns about the robustness of natural systems mandate a better understanding of the dynamic properties of food webs. An innovative modeling technique, developed by the Max Planck Institute for the Physics of Complex Systems in Dresden, now allows efficient analysis of the impact of innumerable parameters on the stability of complex systems. This has enabled scientists from IIASA, Princeton University, and the Max Planck Institute to simulate and analyze food webs—communities of organisms with several inter-related food chains—under a very broad range of conditions, and thus to assess which conditions will keep ecosystems stable and which will upset their balance. The results were published in the 7 August 2009 issue of *Science*.

According to Dr. Ulf Dieckmann of IIASA, this research has uncovered new fundamental rules that determine the stability of ecosystems. "Food-web stability is enhanced when species at high trophic levels feed on multiple prey species, and species at intermediate trophic levels are fed upon by multiple predator species," he says. "Ecosystems with high densities of predator–prey links are less likely to be stable. While a strong dependence of predation on predator densities destabilizes systems, a strong dependence of predation on prey densities will have a stabilizing effect on food webs." ■

Gross I, Rudolf L, Levin SA, Dieckmann U (2009). Generalized models reveal stabilizing factors in food webs. *Science* 325:747–750.



SOLAR ENERGY The cumulative number of installations of solar home systems in India. *Source*: Purohit (2009)

CLEAN DEVELOPMENT MECHANISM

Spotlight on Indian solar

IIASA conducted a macro-level assessment to estimate mitigation potential of solar home systems (SHSs) under the clean development mechanism (CDM) of the Kyoto Protocol, which provides industrialized (Annex-I) countries with an incentive to invest in emission reduction projects in developing (non-Annex-I) countries to achieve carbon dioxide (CO_2) emissions at lowest cost while promoting sustainable development in the host country.

India has one of the world's largest programs for deployment of renewable energy products and systems. Of the total 15,237 MW of renewable energy projects installed in India by July 2009, solar photovoltaic (SPV) accounts for 2 MW (grid-interactive), compared with wind energy 10,464 MW, hydro power 2,461 MW, biomass power 773 MW, bagasse (sugar beet fiber) co-generation 1,155 MW, and waste to energy 59 MW. Even though the Indian government offered financial and fiscal incentives to encourage use of solar energy systems, only 0.45 million SHSs have been installed to date, whereas 78 million rural households remain without access to electricity.

IIASA's Dr. Pallav Purohit says that preliminary estimates based on this study indicate that SHSs could reduce CO_2 emissions by 23 million tonnes on an annual basis by providing domestic lighting to 97 million potential households. "However," he concludes, "SHS projects under the CDM are not as attractive an investment as projects in other sectors unless further supportive policies are introduced." ■

Purohit P (2009). CO_2 emissions mitigation potential of solar home systems under clean development mechanism in India. *Energy* 34(8):1014–1023.

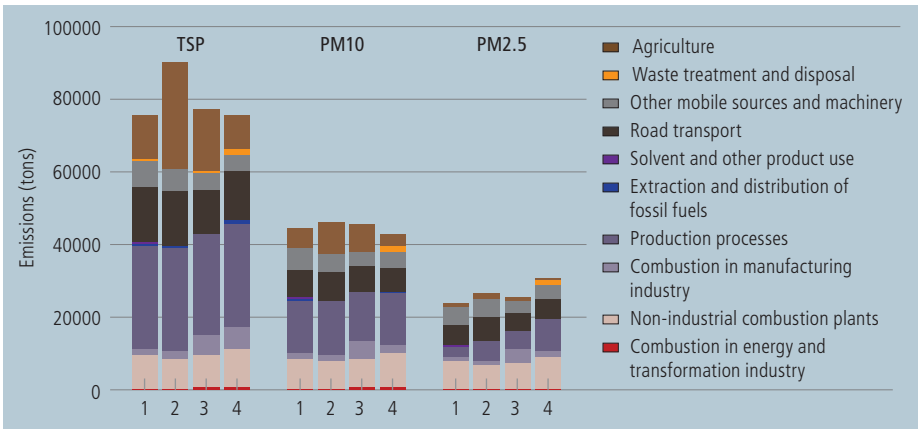
AIR POLLUTION

Particulates and health

An international team led by IIASA has published an evaluation of the current emission inventories for particulate matter (PM) in Europe. According to epidemiological evidence, increased exposure to PM pollution affects human health, causing, for instance, asthma, cardiovascular problems, and altered lung function, as well as contributing to premature death. As emission inventories can help researchers to understand the emission patterns of PM point sources and also differentiate source contributions, they are critical to abatement efforts.

Very specific problems are encountered in assessing PM emissions. According to IIASA's Dr. Wilfried Winiwarter, the large number of PM sources, very different release pathways, and dissimilar chemical composition and size of particles make the creation of comparable inventories difficult. Transfer of material between gaseous and particle phase also makes it difficult to perform appropriate measurements.

A good understanding of the emissions situation is available from point sources.



ESTIMATES OF PARTICULATE MATTER Different approaches to assessing particulate matter (PM) emissions by source sectors yield somewhat different results. Comparing the approaches helps researchers understand their reliability. In the figure a number of national Austrian estimates are compared with IIASA's results for Austria. Results shown are for total suspended particles (TSP) and for the smaller size fractions PM10 and PM2.5. (1) is Winiwarter's 2007 estimate; (2) is the official Austrian inventory; (3) is Winiwarter's 2003 estimate; and (4) is Kupiainen and Klimont's 2004 estimate. *Source*: Winiwarter et al. (2009)

"As transport has been the focus of much research in Europe, knowledge of transport emissions is relatively complete," he says. However, very little is known about fugitive emissions, that is, emissions due to processes that are not confined to an exhaust duct (e.g., quarries, the construction industry, or agricultural operations).

According to Dr. Winiwarter, PM inventories are one of the very few useful tools for the development of PM abatement strategies and policies at the local and European scale. Further knowledge is vital for realistic future policymaking in the health field. ■

Winiwarter W, Kuhlbusch TAJ, Viana M, Hitzenberger R (2009). Quality considerations of European PM emission inventories. *Atmospheric Environment* 43(25):3819–3828.

MONITORING AIR TRANSPORT

European aviation gets a lift

IIASA is one of five European partners in the project, "Monitoring System on the Development of Global Air Transport (MONITOR)," coordinated by the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt) under the European Commission's Seventh Framework Programme (FP7) (Transport). The new project will develop a monitoring system that collects, processes, and analyzes relevant data on the economic, environmental, demographic, and technological dimensions of the global air transport system.

The major objective of MONITOR is to install a system for permanent monitoring of external and internal key factors of strategic importance for a wide variety of aviation stakeholders in order to facilitate timely strategic decision making. At the same time, the monitoring should act as a reporting and early warning system and, through annual workshops, serve as a discussion platform for aviation stakeholders, regulators, and scientists to discuss prevailing problems, aviation challenges, and requirements for further research activities.

The project is expected to generate valuable input for scenario modeling and quantification exercises, thereby contributing to a better understanding of the dynamic nature of developments in air transport. ■

IIASA's Transitions to New Technologies Program
www.iiasa.ac.at/Research/TNT

RESEARCH FOR A CHANGING WORLD

IIASA plans for the next decade

In September 2009 IIASA published its new Strategic Plan (2011–2020). The strategy has two objectives: to focus IIASA's energies on a few major global problems and to use advanced systems analysis to contribute to solutions to them.

Today's world is characterized by increased globalization, fundamental shifts in economic and political power, growing global environmental problems, and potentially explosive social conflicts. Enhanced knowledge and understanding of these complex and interdependent problems are needed to help decision makers chart a successful course through them.

Systems analysis, which is the basis of work at IIASA, is one of the most effective tools for providing such knowledge. IIASA uses the best research, databases, and analytical tools to examine problems from multiple perspectives, including drivers, impacts, and solutions. This "integrated approach" crosses both national and academic disciplinary boundaries and ensures that problems are studied in their complexity and entirety, rather than as isolated issues.

From 2011 the Institute will thus focus its expertise and experience on three major problems: (1) Food and Water; (2) Energy and Climate Change; and (3) Poverty and Equity, together with the main drivers of global transformation, specifically: development and urbanization; economic growth and globalization; population growth and demographic changes; and technological innovations and their diffusion.

While research will remain IIASA's main mission, capacity building and education will also play an important future role. Thus, the Institute will build on its successful Young Scientists Summer Program (YSSP) to create new educational capacities and to offer courses and other study opportunities at IIASA itself and at different global locations.

IIASA will also strengthen its relationship with its National Member Organizations by increasing collaborative research activities, increasing its work with developed countries, and expanding its efforts to address the challenges faced by developing countries. ■

www.iiasa.ac.at/Admin/DI/strategicplan

Wikimedia Commons | Böhringer Friedrich

RISK MANAGEMENT

Landslides for IIASA

IIASA is one of 25 partners from 13 countries in a Consortium, established under the European Commission's Seventh Framework Programme (FP7) for research and technological development: "Living with Landslide Risk in Europe: Assessment, Effects of Global Change, and Risk Management Strategies (SafeLand)." SafeLand will run until March 2011.

Research shows landslides to be one of the eight main threats to European soils, from the northeast English coast to Italian alpine regions. Because of climate change, landslide activity is expected to increase in the future. Methodologies developed during SafeLand will be tested in selected hazard and risk "hotspots" in Europe.

IIASA will develop and test a risk-communication and stakeholder-led participatory process for choosing prevention and mitigation measures, developed within SafeLand, that are most appropriate from the technical, economic, environmental, and social perspectives. The result will be a tested and well documented framework with methodology and procedures for an effective implementation of landslide risk management in all European countries, as well as a toolbox to allow selection of the most appropriate set of mitigation and prevention measures and processes for risk communication, and with which risk reduction targets can be explored. ■

Safeland research project
www.safeland-fp7.eu

FOOD AND WATER

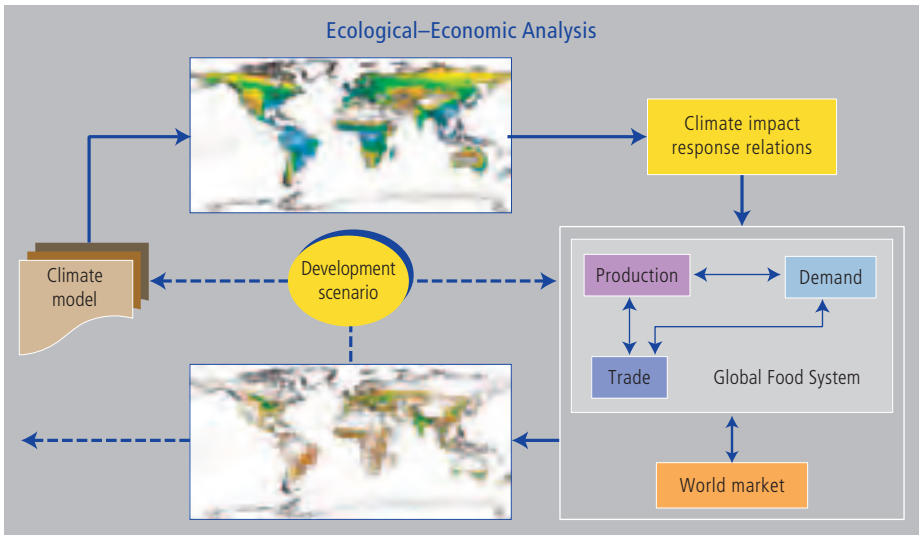
Agriculture in the 21st century

IIASA is preparing a major outlook on agriculture in the 21st century.

The research integrates IIASA's analyses related to a number of issues: future demographic and economic development pathways; sustainable dietary patterns; the potential impacts of climate change on agricultural land suitability and water demand; environmental risks and stability of agricultural production; agricultural science and technology research priorities; competition for land and water by non-food uses, such as biofuels; and assessment of the scale and location of risks of hunger and malnutrition. These analyses draw heavily on IIASA's integrated modeling framework comprising a global spatial agro-ecological zone model and database (GAEZ-2009) and a regionalized general equilibrium model of the world food economy (WFS-2009). The two models provide a tight linkage between the world food economy and agro-environmental resources and form the basis of scenario evaluation and policy analysis of food and agriculture in the 21st century at the national, regional, and global levels (see figure below).

The long-term outlook will be published at the end of 2010. ■

IIASA's Land Use Change and Agriculture Program
www.iiasa.ac.at/Research/LUC



SOLAR POWER

The feasibility of renewable energy in North Africa

The newly adopted EU Directive (2009/28/EC) on renewable energy sources provides a framework for expanding renewable generation by 2020. IIASA, in collaboration with the Potsdam Institute for Climate Impact Research (see page 30), is conducting research for the European Climate Foundation to address a number of questions raised as a result of technical studies of the feasibility of concentrating solar power (CSP) and wind in North Africa.

To date, there has been virtually no scholarship on the subject, which leaves room for uninformed speculation and false expectations that could undermine the credibility of the entire idea. With even more ambitious renewable targets anticipated for 2050, there is a dearth of detailed information to support specific policy proposals for stimulating investments in North Africa to achieve climate protection goals.

IIASA research will look at North Africa's wants and needs regarding investment; the economics of meeting short-term and long-term targets; and policy goals and options for both North African and European policymakers. ■

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

SKILLS IN EUROPE

ERC "Starting Grant" for Vegard Skirbekk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Vegard Skirbekk, Research Scholar with IIASA's World Population Program, has been awarded a €1 million "European Starting Independent Researcher Grant" by the European Research Council (ERC). This is a highly competitive award, with 300 successful research plans approved in 2007 from 9,167 applications.

"The demography of skills and beliefs in Europe with a focus on cohort change" (COHORT) will look at how elements like productivity, attitudes, and beliefs will change in Europe in the next 50 years.

This five-year study will investigate two key topics: (1) human capital, skills, and work performance; and (2) age-related productivity, including how to improve senior workers' skills and capacities—an important issue for many countries with current and future aging populations. The study is expected to yield significant insights that can be used to improve socioeconomic planning in a world where population aging is unprecedented and has major implications for so many facets of life.

Using advanced methodology developed at IIASA, the COHORT team will also study the impact of migration flows, fertility differentials, and intergenerational transmissions, where development patterns are transmitted across generations.

The ERC "Starting Grant" is competitively awarded to young investigators to help them make the transition from supervised working to being independent researchers, accelerating the emergence of the next generation of research leaders and supporting the creation of new research teams. ■

www.iiasa.ac.at/Admin/INF/PR/2009/2009-09-01.html

CLIMATE CHANGE AND AGRICULTURE

Food crops and heat stress

IIASA is producing a global map of the impact of extreme temperatures on food production

It used to be thought that mainly tropical agriculture would suffer from climate change and that agriculture in temperate regions could somewhat benefit from it, as global warming lengthened the crop growing season and released new lands for cultivation. However, such studies did not account for the occurrence of heat stress.

Ongoing IIASA research indicates that heat stress on crops is also likely to decrease food production in temperate and subtropical climates. In fact, extreme high temperature events—as short as hours—can severely impair plant reproductive processes and the formation of grains. Countries with extensive agricultural lands at high latitudes such as Canada, China, Russia, and the United States could experience considerable crop losses caused by heat stress.

The heat wave suffered by Western Europe in summer 2003 is a typical example of how fast short peaks of temperature can cause extensive harm to humans, animals, and plants. In only three months, heat stress is estimated to have caused the death of 52,000 people and decreased the yield of several food crops by 25–35 percent.

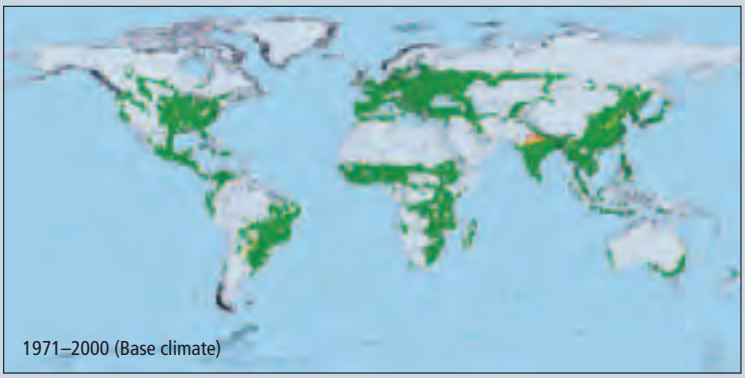
The potential damage of heat stress to global food production, although acknowledged in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) in 2007, has not yet been included in global assessments of food supply. IIASA's Land Use Change and Agriculture Program (LUC) is working in collaboration with Unilever's Sustainable Agriculture team and Professor Frank Ewert of Bonn University in Germany and Wageningen University in the Netherlands to develop a global map of heat stress hotspots for key agricultural crops. The map will indicate regions and countries where food production may be threatened by the increased frequency of extreme temperatures resulting from climate change.

To create the map, one of LUC's land use models has been used to identify the most probable crop calendars and thermal-sensitive development phase for wheat, maize, rice, and soybean crops which, together, provide a large proportion of the calories consumed by the human population. Preliminary results are already bringing new insights into this topic, indicating that climate change may take a higher toll on food production in temperate countries than previously projected (see maps).

Average multi-model projections by the IPCC show larger temperature increases at high latitudes. This, together with higher temperature variability, substantially increases the risk of heat stress in these regions. Heat stress adds to other important effects of global warming on crop growth and development. The increase in crop water demand (due to increase in evapotranspiration), the acceleration of crop development (i.e., shortening of crop cycles), and an increase in night respiration are examples of impacts on both tropical and temperate crops.

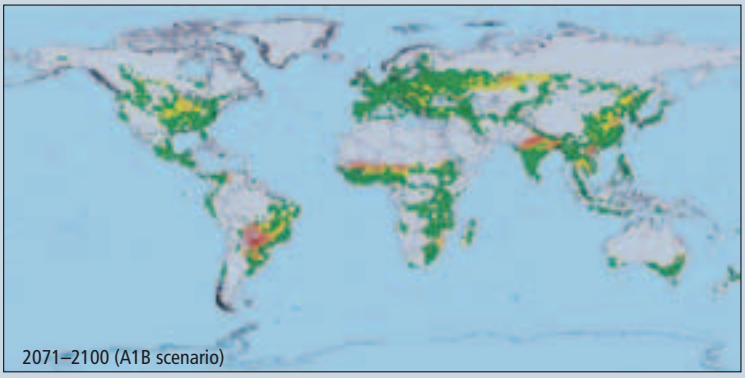
Taken together, these factors show how urgent the need is to plan adaptive strategies for agriculture. Investments to support adaptation are vital to prepare current agricultural production systems for a warmer environment. It is of great concern that in recent years so much investment in global agricultural R&D has been reduced and shifted from the public to the private sector. Technically, adaptation seems possible, as there is a wide genetic variability for tolerance to high temperatures within and among plant species. This genetic diversity can be explored in breeding programs in conjunction with selecting for drought resistance and yield increase. Adaptation of agricultural practices, such as shifting sowing time and change in land use options, could also be explored as regional strategies to minimize the impact of climate change on food production as a whole.

IIASA's research is a first step toward enabling current and future heat stress hotspots to be identified to help tailor specific adaptation strategies for those regions that are the most at risk. ■



Water
Suitable land
Low stress
Medium stress
High stress
Unsuitable land

HEAT STRESS IMPACTS ON MAIZE CROPS
The maps depict the impacts of heat stress on maize during the hottest year between 1971–2000 (above) and 2071–2100 (below). The increase in heat stress by the end of the 21st century assumes a world with an average temperature increase of around 2.8 °C by 2100 (the A1B scenario).



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

Dr. Edmar Teixeira is a Research Scholar in IIASA's Land Use Change and Agriculture Program.

DEFORESTATION

Fragile ecosystem—Robust research

IIASA is a key partner in a new project to determine the main drivers of deforestation and forest degradation in the Congo River Basin over the next 50 years

DEFORESTATION This 2009 satellite image of the Nord-Ubangi and Mongala provinces of the Democratic Republic of the Congo shows the deforested areas as brown in the otherwise dense rain forest. *Source*: IIASA's Geo-Wiki.org, a tool to improve the quality of global land cover maps, and Google Earth.

Home to the second-largest contiguous block of tropical forest in the world, to rivers, lakes, wetlands, and an abundance of biodiversity, the Congo River Basin is a vast oasis in a dry continent—a carbon-sink and rainfall provider for the countries within and around it.

Unlike Amazonia and Southeast Asia, the 3.68 million km^2 area of the Congo rainforests has not yet been plundered on the grand scale. However, poorly managed logging concessions, illegal logging, and damage caused by poachers are putting the forests under pressure. So, too, is development. Agribusinesses are springing up in response to demand for food and biofuel; greater mobility is reflected in an expanding road network and growing urban sprawl; oil and mineral wealth is being increasingly exploited—much of this at the expense of the forests. Some 934,000 hectares of forest are lost each year in the Congo Basin.

Deforestation and degradation, mainly in tropical forests, produce up to 20 percent of all greenhouse gas emissions. With the living carbon storage capacity of forests diminishing at a rapid scale globally, many believe that stopping deforestation and forest degradation must become a fundamental part of overall approaches to climate change mitigation.

The leaders of the six Congo Basin nations—Cameroon, Central Africa Republic, Democratic Republic of Congo, Equatorial Guinea, Gabon, and Republic of Congo—have made efforts to control deforestation for over two decades. New life has been breathed into that work by the global initiative on Reducing Emissions from Deforestation and Forest Degradation (REDD), a major agenda item at the forthcoming UN Climate Change Conference in Copenhagen.

IIASA's Forestry Program is making a major contribution in modeling and policy development to a new World Bank–sponsored project, "Economic Growth and Deforestation in the Congo Basin," which will identify and assess current patterns of land use, land cover, and deforestation to determine the main potential drivers of deforestation/degradation and trends for the next 10–50 years and inform potential development and policy decisions accordingly.

This project will build capacities and provide decision-making support for the entire region. IIASA will summarize the data, results, and potential next steps for a wide range of stakeholders, advise and train the key negotiators for future discussions on reducing emissions from deforestation and forest degradation, and train country teams in data gathering, policy review, and modeling of land use change and development. Local actors will access data and scenario maps using a graphical interface and Google Earth.

The preliminary findings of the study are expected to be presented at the UN Climate Change Conference in Copenhagen in December 2009, where IIASA will give a presentation in partnership with Congo Basin country representatives. ■

Further information IIASA's Forestry Program at www.iiasa.ac.at/Research/FOR

Dr. Kentaro Aoki, **Dr. Steffen Fritz**, **Dr. Mykola Gusti**, **Dr. Petr Havlik**, **Dr. Sylvain Leduc**, **Mr. Ian McCallum**, **Ms. Aline Mosnier**, and **Dr. Michael Obersteiner** are Researchers in IIASA's Forestry Program.

GOVERNANCE

Regional solutions for global problems

Effective regional energy governance—not global environmental governance—is what we need right now for climate change

Credit: Wikimedia Commons

According to conventional wisdom, climate change is a global problem and therefore requires a global solution. The perfect prototype for a successful global treaty is a multilateral environmental treaty like the Montreal Protocol to the Vienna Convention on Protection of the Ozone Layer, an international instrument that has dramatically reduced the ozone-layer-unfriendly chemicals used in refrigeration processes.

But it has already been almost 20 years since countries first signed the United Nations Framework Convention on Climate Change (UNFCCC), and in that time relatively little has been achieved in terms of limiting energy use from fossil fuels. Why is the world again struggling to draft an international treaty on climate change, especially as the dangers of climate change have been known about for far longer than the hole in the ozone layer?

Credit: Potsdam Institute of Climate Impact Research (PIK)

SOLAR POWER FROM THE SAHARA European and North African countries have expressed an interest in generating far more electricity from solar power stations in the Mediterranean basin to serve both continents' power markets. Making this work at a technical level, will require a dense network of international transmission lines as suggested in the map.

IIASA's Anthony Patt argues that agreeing on global regulation to shift countries' energy systems away from fossil fuels, a necessary element of a successful climate change treaty, is currently a step too far for many nations. Instead, a practical and achievable first step toward lowering carbon emissions from energy production would be cooperation and governance of energy systems at a regional scale.

Currently, national governments are extremely risk-averse regarding signing away any control of their energy system. A country's energy security is central to its economic growth, employment, and quality of life. Even within the European Union "region," where delegation of national sovereignty has progressed relatively far, energy policy stands out as an area where member states have retained almost complete national autonomy, despite vision statements from Brussels to the contrary.

In the current climate change negotiations, however, a considerable lack of trust has developed between industrialized and industrializing countries. This has been exacerbated by the failure of the former to follow through on their promises to financially support the latter to help them adapt to the negative consequences of climate change—a situation caused, on the whole, by the industrialized countries themselves. Overcoming this particular barrier to a global climate change deal is possible but not easy; it will probably occur only incrementally, with each increment building trust for the next step.

But the world doesn't have that long to wait; it is crucial for new energy sector investment to shift to carbon-neutral supply options almost immediately in industrialized countries, and within 20 years in developing countries. This could happen, even in the absence of a strong global treaty, if renewable energy options were simply a better deal than fossil fuels. This is poised to happen, in particular, for two technologies: wind and concentrating solar power (CSP). But allowing either technology to continue to grow, and to achieve competitive status within the next 10 to 20 years, requires far greater regional cooperation than that which now exists.

European and North African countries have expressed a desire to scale up CSP investment in the Mediterranean basin, to serve both continents' power markets. Making this work at a technical level, however, will require moving the locus of transmission grid planning from the national to the regional level, facilitating the construction of a far denser network of international transmission lines than now exists. And it will require a shift in thinking on the part of many European countries: that they will import a large fraction of their electricity, much as they now import fossil fuels and uranium.

Actions of this type could make a comprehensive global deal less urgent by enabling renewable energy to take off. Paradoxically, they could also make a global deal more likely. As countries become accustomed to supra-national institutions deciding important energy issues, the risks of global cooperation will seem less severe. Stronger regional cooperation is an essential step—needed now—to solve climate change. ■

Further information Patt A (2009). Effective regional energy governance—not global environmental governance—is what we need right now for climate change. *Global Environmental Change*. In press.

Dr. Anthony Patt leads the Decisions and Governance research group in IIASA's Risk and Vulnerability Program.

UN SECRETARY-GENERAL BAN KI-MOON witnesses impacts of climate change in the Arctic (01 September 2009).

UN Photo | Mark Garten

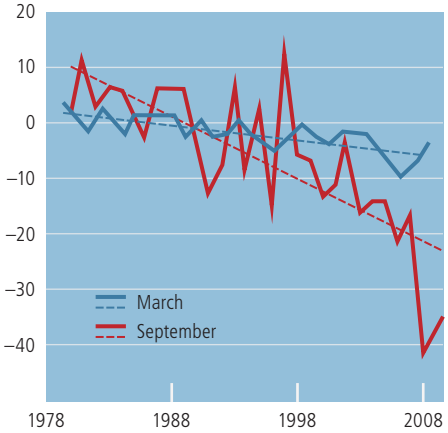
AIR POLLUTION

White paper for black carbon

IIASA is contributing to an Arctic Council task force working to mitigate the impact of black carbon emissions on the Arctic region

According to the 2007 report of the International Panel on Climate Change (IPCC), the Arctic warmed at twice the global rate over the last century. Scientific opinions differ on how long it would take, under current global warming conditions, for the north polar ice cap to disappear. Although the 2001 IPCC Third Assessment Report predicted it would last until 2100, the record "meltdown" during the 2007 northern summer and the only slightly bigger summer ice extent in 2008 and 2009 (second and third lowest, respectively) has led to more pessimistic prognoses, with some suggesting an ice-free summer Arctic as soon as 2020.

Although carbon dioxide is the main contributor to the high rates of observed warming and ice melt in the Arctic, there are concerns about how short-lived climate forcers (SLCF), especially black carbon (BC) or "soot"—the small particles left after incomplete combustion of fossil fuels and biomass—may contribute, with some estimating total SLCF warming as equal to that of CO_2. Atmospheric BC affects climate via a number of pathways; BC deposited on snow and ice, for example, results in darkening of the surface which absorbs more radiation, accelerating melting. BC is also a component of particulate matter, which is recognized as having adverse health effects.



SEA ICE EXTENT Percentage difference from 1979–2007 average. *Source*: AMAP (2009). AMAP 2009 Update on Selected Climate Issues of Concern. Arctic Monitoring and Assessment Programme, Oslo. ISBN 978-82-7971-049-3, www.amap.no.

Unlike long-lived CO_2, black carbon, which is the third- or by some estimates even second-biggest contributor to global warming, remains for only days to weeks in the atmosphere. Reducing it has the benefit of a swift climate response, which can make an immediate difference to mitigation strategies.

IIASA has been actively involved in SLCF through its air pollution work for a number of years, and most recently has become engaged in work with the Arctic Council. In preparation for the Arctic Ministers meeting in late April 2009, IIASA co-authored the Draft White Paper "Current Policies, Emission Trends and Mitigation Options for Black Carbon in the Arctic Region." This paper was discussed by both the Arctic Ministers and at the International Melting Ice Conference.

The White Paper shows that while some BC is produced in the Arctic itself, for example, by ships traveling through the region, most pollution occurs as fall-out from the eight Arctic Council nations and the near-Arctic regions (north of approximately latitude 40), which includes much of the European Union, Russia, Ukraine, China (north of Beijing), Canada, and part of the United States. Use of diesel fuel, open burning (both agricultural burning and wildfires), and residential combustion of solid fuels account for most BC that reaches the Arctic.

The Paper was the basis for the establishment by the Arctic Ministers of a Task Force to examine in greater detail the role and mitigation potential of SLCF in the Arctic. IIASA's expertise will continue to be tapped and will be particularly important in finalizing the White Paper. The Task Force hopes to hold a side event at COP15 in Copenhagen highlighting this work.

Future work will expand beyond black carbon and include precursors for tropospheric ozone, including methane. A major contribution of IIASA will be to apply the GAINS model (see page 16–17) to project the effect of current and forthcoming air quality policies, specifically those implemented to reduce particulate matter emissions, as such policies will considerably reduce BC. Results from GAINS and other tools will allow the climatic impact of BC over time to be evaluated in terms of changes in geographical and sectoral distribution of emissions; they will also identify where additional mitigation measures can make a difference and at what cost. The work has been supported by the Clean Air Task Force (www.catf.us), a U.S.-based NGO that has been working extensively in this area.

Independently, IIASA has been working on the assessment of the transport of particulate matter pollution from Europe to the Arctic. The first results are summarized in a forthcoming IIASA Interim Report, prepared by Gregor Kiesewetter, a participant in the 2009 Young Scientist Summer Program. ■

Further information www.iiasa.ac.at/rains/reports/DRAFTWhitePaper-BCArcticMitigation-280909.pdf

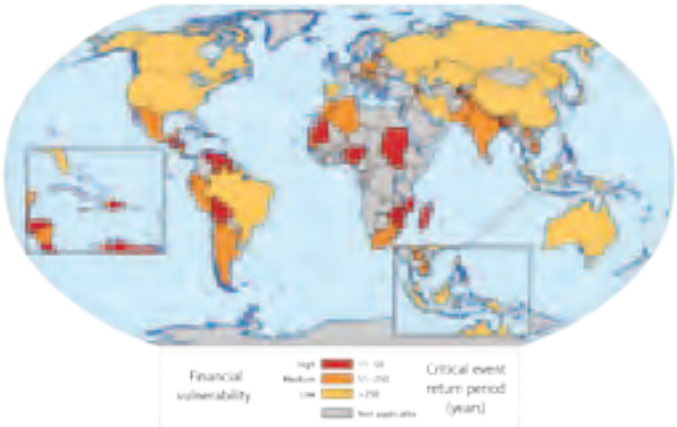
Zbigniew Klimont is a Research Scholar in IIASA's Atmospheric Pollution and Economic Development Program.

At the 2007 United Nations Climate Change Conference in Bali, the participating countries called upon policymakers to consider insurance as part of a post-Copenhagen adaptation strategy. Insurance mechanisms offer substantial benefits for developing countries, both in reducing their vulnerability to climate variability and helping them adapt to climate change.

IIASA and the Munich Climate Change Insurance Initiative (MCCII) have proposed an insurance approach designed to help developing countries better prepare for, and recover from, extreme climatic events, by reducing risk, promoting adaptation, and adopting a comprehensive approach to risk management.

Insurance in a changing climate

Over 95 percent of deaths from natural disasters in the last 25 years occurred in developing countries. Direct economic losses averaged US$100 billion per annum in the last decade. In gross national income terms, these were more than twice as high in low-income countries as in high-income ones. According to the United Nations International Strategy for Disaster Reduction (UNISDR), more than three-quarters of recent economic losses can be attributed to climate-related hazards. The Intergovernmental Panel on Climate Change (IPCC) has also predicted that increasing weather variability due to climate change will make matters even worse.



FINANCIAL VULNERABILITY TO EXTREME WEATHER EVENTS Countries in red are vulnerable to severe weather events that are expected once every 11 to 50 years. The event would exceed the public sector's financial ability to restore damaged infrastructure and continue other planned development projects. *Source*: IIASA (Mechler R, Hochrainer S, Pflug G, Lotsch L, Williges K) as published in the *World Development Report 2010*.

A recent study by IIASA, published in the *World Development Report 2010* (see map), has also identified the countries most vulnerable to extreme events and the associated economic costs likely to be incurred by them, providing further guidance on those most likely to benefit from insurance support.

Insurance—Why, and when to apply it?

Donor aid, while an invaluable mechanism for post-disaster recovery, is not necessarily sustainable, as extreme events escalate in scale and frequency. In turn, external investors are wary of the risk of catastrophic infrastructure losses, while small firms and farmers cannot access the credit necessary for investing in higher-yield/higher-risk activities. This leads to slowed economic recovery and prolonged poverty. A different mechanism is needed.

While insurance will not necessarily be appropriate for slow-onset climate impacts, such as sea-level rise and desertification, when applied as part of a broader climate change risk-management strategy, insurance mechanisms may be a powerful tool to help avoid or minimize human and economic losses following environmental catastrophes.

Well designed and implemented insurance reduces disaster losses. By providing early liquidity, it prevents long-term loss of livelihood and lives; by pricing risk, it sets strong incentives for pre-disaster preventive behavior; and by providing security it enables high-return, high-risk investments, reducing vulnerability to disasters.

Still, the costs of insurance can greatly exceed the ability to pay of the poor who, without support, will continue to rely on insufficient and ad hoc international aid.

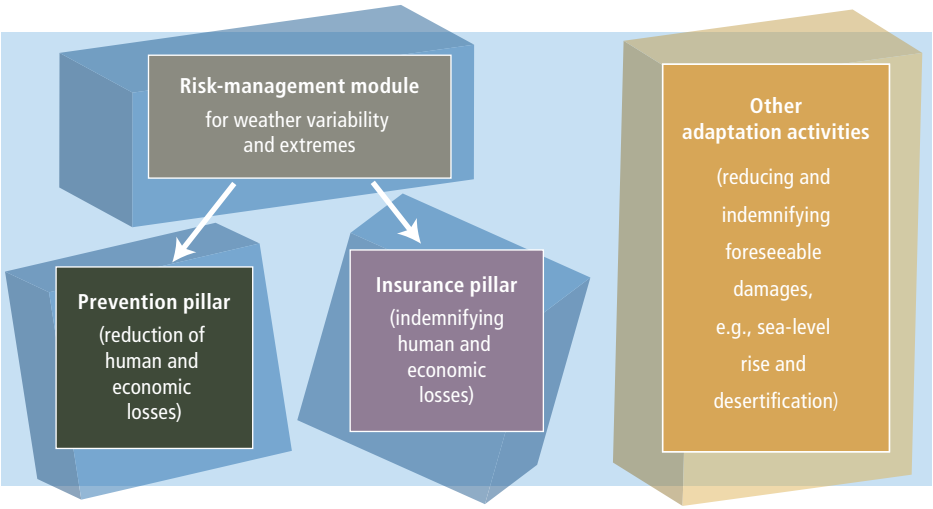
How are insurance approaches being applied in developing countries?

Donor-supported catastrophe insurance is playing an increasingly visible role in developing countries. Novel programs are demonstrating not only their potential to pool economic losses and smooth the incomes of poor people facing weather variability and climate extremes, but also to transfer risks to the global capital markets. For example:

- In *Malawi*, smallholder farmers can now buy affordable, index-based drought insurance. Unlike traditional claims-based insurance, indemnity is based on an index of local rainfall. By making farmers more creditworthy, this pilot loan/insurance scheme enables farmers to purchase hybrid seeds and thus greatly increase productivity.
- To insure against insufficient funds for post-disaster relief and infrastructure repair, the *Mexican government* has insured its catastrophe reserve fund, including a catastrophe bond, which pays an above-market interest rate if rainfall exceeds a specified level, with part of the principal going to the Mexican government if rainfall is below this level.
- The *Caribbean island states* have recently formed the world's first multi-country and index-based catastrophe insurance pool to provide governments with immediate liquidity in the aftermath of hurricanes or earthquakes.

While it may be too early to assess if such internationally backed systems are viable in the long haul, they may radically change the way development organizations provide disaster aid and support adaptation to climate change. They may also provide a cornerstone of a post-Copenhagen adaptation strategy.

AN EFFECTIVE INSURANCE MECHANISM in developing countries could • provide security against loss of assets, livelihoods, and lives in the post-disaster period • change the way development organizations provide disaster assistance and engage the private sector in vast markets • ensure reliable and dignified post-disaster relief • create incentives for prevention • encourage economic development.



THE MCII PROPOSED RISK-MANAGEMENT MODULE, together with other adaptation activities, would help vulnerable countries adapt to climate change.

IIASA and the Munich Climate Insurance Initiative (MCII) have proposed a risk-management approach to adaptation consisting of two pillars, prevention and insurance, which together would reduce the human and economic burdens on developing countries (see figure above and Winter 2008 edition of *Options*). Both pillars could be financed by a post-Copenhagen multilateral adaptation fund.

The prevention pillar focuses on risk prevention through targeted risk assessments and identification of strategies to minimize risk exposure, such as the use of early-warning systems and land-use restrictions, and help lay the groundwork for risk-transfer systems. Qualification for participation in the insurance pillar might include progress on a credible risk-management strategy, with a specific focus on the most vulnerable communities and sectors.

The insurance pillar has two tiers, reflecting the different layers of risk that need to be addressed for effective climate adaptation.

Tier 1 takes the form of a solidarity fund, or Climate Insurance Pool (CIP) and would provide insurance cover to vulnerable governments for a predefined high-risk (e.g., very low-frequency, high-consequence events), and the premiums would be paid from a post-Kyoto adaptation fund. The CIP operations would be managed by an insurance team responsible for risk pricing, loss evaluation, and indemnity payments, as well as placing reinsurance.

Tier 2 would be in the form of a Climate Insurance Assistance Facility and would enable mainly micro-scale risk-pooling and transfer mechanisms that provide cover for medium-loss events (e.g., a 1 in 50 year event). This tier would provide direct insurance to households, farmers, or governments, and offer support to nascent micro-, meso-, and macro-scale disaster insurance systems, like those operating in Malawi and the Caribbean.

In the context of a post-Kyoto adaptation strategy the MCII proposal offers the following unique and humane principles: it prioritizes vulnerable countries and people; it puts risk reduction in vulnerable countries first; it offers incentives for communities to set and reach risk reduction goals; it is holistic in that it addresses low-, medium-, and high-risk events; and it recognizes that effective adaptation starts locally, by working with communities to tailor insurance schemes to their needs.

The Copenhagen climate change conference is a unique opportunity to establish a comprehensive risk-management framework that prioritizes disaster risk reduction and uses insurance mechanisms, such as those proposed by the MCII, to help achieve adaptation in vulnerable countries and for vulnerable people. ■

Further information Linnerooth-Bayer J, Bals C, Mechler R (2009). Insurance as part of a climate adaptation strategy. In: *Making Climate Change Work for Us: European Perspectives on Adaptation and Mitigation Strategies*, M Hulme, H Neufeldt (eds), Cambridge University Press, Cambridge, UK.

Dr. Joanne Linnerooth-Bayer is Leader of IIASA's Risk and Vulnerability Program.

The energy to combat climate change

No-one disputes the pressing need for world leaders to agree a climate deal in Copenhagen in December. However, unless there are radical changes in the ways we source and distribute energy around the world, climate change initiatives will unquestionably founder.

The myriad interconnections between climate change and energy were formally recognized in 2005 with the founding at IIASA of the Global Energy Assessment (GEA), which is due to report in fall 2010—less than a year after the leaders of global governments and civil society meet to work out a global climate deal in Copenhagen. The GEA is perhaps the most ambitious multidisciplinary energy assessment ever undertaken, with leading world energy experts and institutions having committed to a five-year research effort to rethink approaches to energy from scratch and advise policymakers accordingly.

Climate change and energy are "joined at the hip." Since the industrial revolution, when fossil fuels started being burned on an accelerating scale to power manufacturing and growth, the energy supply has acted as an arbiter of development, splitting the world into the haves and the have-nots. Energy's effects on climate change, however, have been far from arbitrary; greenhouse gases and pollution from energy generation are producing impacts at the global scale. The inequitable global distribution of energy has resulted in energy poverty in many regions—including over-reliance on traditional biomass for cooking in the developing world, which only serves to exacerbate pollution and climate warming.

Thus, as global leaders sit down to discuss climate change in December, it is worth remembering that although "climate change" is the centerpiece of the global agenda at Copenhagen, addressing energy and related global problems is also a vital part of slowing global warming. A clean, sustainable, equitable energy supply can only heighten the prospects for achieving future climate targets. Indeed, unless major policy reforms and technologies are introduced to transform the ways we produce and consume energy, global-energy-related carbon dioxide emissions will increase by some 50 percent between 2004 and 2030.

It might be obvious from a present-day standpoint that studying different global problems from a single compartmentalized perspective is no longer feasible. However, four years ago when the GEA was founded, the initiative was unique in assessing energy's impact on many social, economic, and sectoral issues, and vice versa. It would take an occurrence of the magnitude and with the massive fall-out of the global economic and financial crisis of late 2008 to shock the complacent majority into comprehending that the era of individual, corporate, and national self-interest was effectively over and that a holistic approach to sustaining life on the planet was needed.

Although inside-the-box and short-term thinking in some quarters still need to be addressed, GEA work recognizes that integration and cooperation are, in fact, the new "modus survivendi." Its integrative approach links climate change with sustainable economic growth, with expanded access to modern energy services for poor and rural populations, with alleviation of local, regional, and global environmental impacts, with securing energy/fuel supply and investment. "With" is the operative word, with cooperation being the driving force behind this venture.

To make this "with list" happen, GEA is actively contributing to the work of important energy initiatives worldwide. As well as working with large academic institutions and leading energy researchers, it has also formalized partnerships with national and international organizations, which have been mutually enriching in terms of multi-directional insights and knowledge.

Ultimately, however, it is the national politicians who will need to be convinced to sign on the dotted line at Copenhagen, and this will not happen unless a climate change agreement is in everyone's best interests. Backed by a far-sighted, inclusive, politically sensitive global energy strategy, it will be.

Take energy security, for example. A modern state critically depends upon the uninterrupted flow of energy to transport, the residential sector, vital industry, infrastructure, and other key components of a national economy. In many countries, concerns over adequate, reliable, and affordable energy supplies feature prominently on the national security agenda. At the same time, energy system vulnerability is increasing—more so in poorer countries—with rising demand, geographic concentration of key resources such as oil, and energy systems increasingly operating near their critical loads because of underinvestment and poor maintenance. Some governments and private actors may seek to secure control over energy resources and systems by political and even military means which entangles energy with a broader security agenda ranging from defense spending to stability of governance. GEA is actively engaged with the Global Environment Facility, a major funder of projects to improve the global environment, in preparing energy policy tools that can be easily accessed and used by policymakers throughout the developing world. It is hoped that this advice and support in the form of capacity building on energy issues, such as those mentioned above, will make a future international climate change treaty more realistically achievable.

The participation and backing of international institutional efforts have lent integrity and authority to GEA's work. It is an active key member of UN Energy, established to enhance effective and coordinated action on energy by the United Nations, and encompassing 20 UN agencies plus the World Bank. The main focus of its work is renewable energy, energy efficiency and energy access—three key GEA areas.

GEA, through its Director Nebojsa Nakicenovic and his team, also makes a major contribution to the Advisory Group to the Secretary-General Ban Ki-moon on Energy and Climate Change. It provides analysis and advice on assessing the most realistic options for avoiding dangerous climate change and the best way of facilitating science-based decision making—both of which will be key to the successful implementation of a new global deal on climate change. ■

Further information www.globalenergyassessment.org

Luis Gomez-Echeverri is Associate Director and **Martin Offutt** is Senior Program Officer of the Global Energy Assessment.

About the Global Energy Assessment

The Global Energy Assessment (GEA) is a major, multi-year initiative to define a new global energy agenda for a rapidly changing world. It brings together approximately 200 analysts from over 70 countries to contribute independent, scientifically based, integrated, and policy-relevant analysis of current and emerging energy issues and options. The GEA will go beyond existing studies by virtue of its unique integrative approach, the breadth and depth of the issues it will examine, and the stakeholders it will engage.

The GEA will address the following major topics:

- Affordable, secure, sustainable energy supplies and services for economic growth
- Achieving equity and ensuring access for all to modern forms of energy
- Climate change mitigation
- Environmental and health impacts of energy production, transport, processing, and use
- Security and peace issues, including concerns about nuclear proliferation
- Ancillary risks and multiple benefits of energy systems
- Develop scenarios that combine incentives, technologies, and non-energy-related policies (e.g. public transport) to harness potential energy efficiency gains
- Regional and place-based case studies that generate insights into combinations of demand management, resources, and technologies that meet multiple objectives and aspirations
- Effective allocation of public R&D funding for the energy transition
- Role of public-private cooperation in energy for sustainable development

The GEA is coordinated by IIASA's Energy Program, and is also funded by Climate Works Foundation in the USA, Energy Sector Management Assistance Program (ESMAP) of the World Bank, European Union, First Solar Inc. in the USA, Global Environment Facility, Petrobras in Brazil, United Nations Foundation, United Nations Development Programme, United Nations Environment Programme, United Nations Industrial Development Organization, US Department of Energy, US Environmental Protection Agency, World Energy Council, and the governments of Austria, Italy, and Sweden.

The GEA is under the leadership of the GEA Council with co-presidents Ged Davis, a senior international consultant, and Jose Goldemberg, Professor Emeritus, University of Sao Paulo, Brazil. The GEA Executive Committee is responsible for developing the Assessment's content and is co-chaired by Thomas B. Johansson from Lund University, Sweden, Feng Fei from the Development Research Centre of China, and Anand Patwardhan of the Shailesh J. Mehta School of Management, Indian Institute of Technology–Bombay. ■

WWW.GLOBALENERGYASSESSMENT.ORG

THE IIASA GAINS MODEL

IIASA research sheds new light on two major questions facing negotiators of an international climate change agreement: (1) How much are industrialized countries willing to reduce their emissions of greenhouse gases? and (2) How much are major developing countries like China and India willing to limit the growth of their emissions? The research uncovers the most cost-effective options available and reveals significant additional benefits, including improvements to health and crop production.

IIASA

CURTAILING EMISSIONS •

IIASA'S GAINS MODEL TACKLES AIR POLL EMISSIONS *SIMULTANEOUSLY*, ENABLING

The GAINS (Greenhouse gas – Air pollution INteractions and Synergies model) is an interactive, scenario-generating tool that allows users to identify the best strategies for simultaneously reducing air pollution and greenhouse gas (GHG) emissions.

The GAINS analysis includes all six GHGs included in the Kyoto Protocol (CO_2, CH_4, N_2O, HFCs, PFCs, and SF6) and covers all anthropogenic sources included in the emission reporting of UNFCCC Annex-I countries. GAINS considers around 300 different national mitigation options, including technological advances, carbon trading schemes, land use and land use change and forestry, and development and population growth.

COUNTING THE COST OF REDUCING EMISSIONS

In 2007 the Intergovernmental Panel on Climate Change (IPCC) argued that greenhouse gas (GHG) emissions from Annex-I (industrialized) countries must fall by 25–40 percent by 2020 compared with 1990 to keep global warming to a maximum of 2 °C. Using the GAINS model, IIASA scientists have analyzed public "pledges" to reduce emissions made by policymakers and found that they fall significantly short of the IPCC recommendation.

As of mid-August 2009, most Annex-I parties to the United Nations Framework Convention on Climate Change (UNFCCC) have presented GHG emissions reduction targets ("pledges") ahead of the UN Climate Change Conference in Copenhagen in December 2009. These pledges, based on official and unofficial announcements, have been evaluated by IIASA using its GAINS model (described above, center). The results show that the total GHG emission reductions being pledged by Annex I countries will fail to meet the 25–40 percent IPCC target. They also show, importantly, that the cost of meeting the targets is much lower than Annex-I countries anticipate.

This raises two points. First, any emission reductions agreed at Copenhagen need to be far steeper than countries have pledged to date so as to achieve the range outlined by the IPCC. Second, the financial cost of making these bigger emission cuts is lower than countries' estimates.

In fact, the IIASA GAINS analysis shows that if the "pledges" were implemented, the total GHG emissions of Annex-I countries, relative to 1990, would decrease by only 5 percent, for a conservative interpretation of the "pledges," to 17 percent, for an optimistic interpretation. The GAINS analysis also suggests that the conservative 5 percent reduction would involve no net costs to Annex-I countries as a whole, as most of the reductions could be satisfied by accounting for surpluses through emission permits, a factor implicit in some countries' "pledges." Remaining emission cuts could be achieved through low-cost energy efficiency measures such as improved insulation of buildings or more efficient vehicles, which pay for themselves over their lifetime.

Even for the most optimistic 17 percent emissions reduction, mitigation costs would not exceed 0.01–0.05 percent of the GDP of all Annex I countries—a minor amount, given the projected 42 percent increase in GDP for these countries between now and 2020. Moreover, the economic crisis means emissions will likely be lower and the costs of reaching the "pledges" even lower than suggested in the IIASA study.

The GAINS approach was presented at the November UNFCCC Barcelona climate change talks and will be presented at the UN Climate Change Conference in Copenhagen. ■

Further information Wagner F, Amann M (2009). *Analysis of the Proposals for GHG Reductions in 2020 made by UNFCCC Annex I Countries By mid-August 2009.* GAINS Report.

EMISSION REDUCTION PLEDGES Until mid-August 2009, the of greenhouse gas emission reductions by 2020.

	Conservative interpretation	Optimistic interpretation
Australia	–5%	–25% through –20% cap and trade of domestic emissions and –5% government purchases of international credits
Canada	–20%	–20%
EU	–20%	–30%
Japan	–15% (relative to 2005; through domestic measures)	–25% (relative to 1990)
New Zealand	–10%	–20%
Norway	–30%	–30%
Switzerland	–20%	–30%
Ukraine	–20%	–20%
USA	–1% (cap: 6,095 Mt CO_2eq)	–17% (5,123 Mt CO_2eq) (through cap plus complementary measures)
Russia	–10%	–15%

GAINS

CLEANING AIR ● CUTTING COSTS

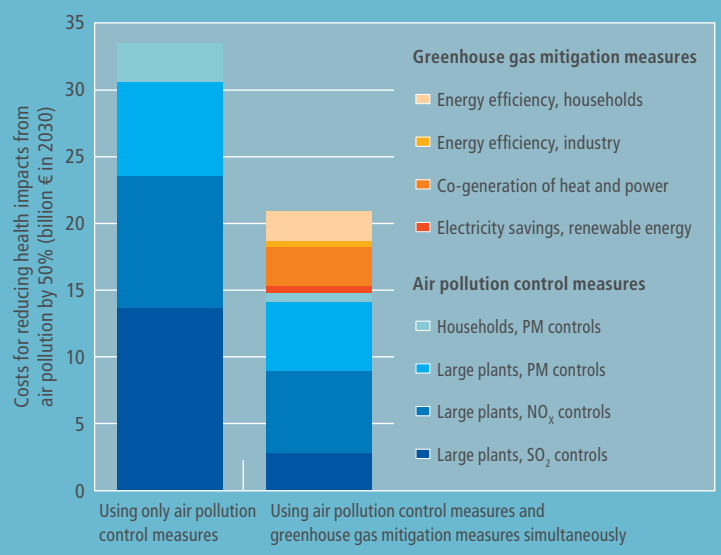
LUTION AND GREENHOUSE GAS
GREATER CUTS AT LOWER COST

GAINS, which includes a freely available online emissions calculator, quantifies the implications for and co-benefits of GHG mitigation strategies on air pollution, and vice versa.

Under the EU Sixth Framework Programme on Research, an international team of research institutions has implemented the GAINS model for India and China. The research team, headed by IIASA, included the Chinese Energy Research Institute, Tsinghua University (Beijing, China), The Energy and Resource Institute (New Delhi, India), the Institute for Environment and Sustainability of the Joint Research Centre of the European Commission, and the University of Bern (Switzerland).

Annex 1 (industrialized) countries had publicly pledged a range

Reference year	Inclusion of LULUCF	Status
2000	Yes	Officially announced (4 May 2009)
2006	t.b.d.	Officially announced
1990	Not for the 20% target, t.b.d. for the 30% target	Adopted by legislation
	Not for the 15% target, t.b.d. for the 25% target	Low pledge announced by the previous government; high pledge announced by the new government
1990	Yes (with current rules)	Announced in Bonn (11 August 2009)
1990	Yes (with current rules)	Officially announced
1990	Yes	Switzerland announced it will follow the EU
1990	?	Under consideration
1990	Yes	Waxman-Markey Bill of 19 May (WRI paper 22 June 2009)
1990	?	Announced by President Medvedev



CUTTING GREENHOUSE GAS EMISSIONS & LOWERING AIR POLLUTION CONTROL COSTS
By using a "smart mix" of air pollution control measures and greenhouse gas mitigation measures, China could lower air pollution costs and cut greenhouse gas emissions by 8 percent at no additional cost by 2030.

IMPROVING HEALTH AND LIVELIHOODS IN CHINA

Air pollution is an immediate concern for many countries, damaging both human health and crop production. IIASA research estimates that in China exposure to fine particulate matter (PM 2.5)—one among many air pollutants—is shortening average individual life expectancy by approximately 40 months. Today, China spends about €14 billion annually (0.37 percent of GDP) on cleaning its air. With Chinese economic growth expected to burgeon over the next decades, the country faces growing air pollution and a potentially massive rise in mitigation costs.

IIASA has been working with Chinese partners using the GAINS model to identify the best combination of strategies for simultaneously reducing air pollution and GHG emissions and thereby help China cut its future mitigation costs.

Today, many industrialized countries use advanced emission control technologies to maintain their air quality levels. If China were to adopt such technologies, it could, according to IIASA estimates, reduce the negative health impacts of air pollution by 43 percent by 2030 at a cost of 0.63 percent of GDP. The IIASA GAINS model, however, which takes into account that air pollutants are often emitted from the same source as greenhouse gases and interact with them in the atmosphere, enables air pollution and greenhouse gas strategies to be developed simultaneously and thus much more cost-effectively. The *simultaneous* reduction of air pollution and greenhouse gases is advantageous not only from the financial perspective, but also for human health.

In fact, use of the GAINS model has identified a "smart mix" of the latest technology and the structural changes needed to China's energy system that will allow China to achieve the same air quality improvements at only 20 percent of the costs of the conventional across-the-board approach, while at the same time improving its population's health and reducing crop losses due to air pollution by 50 percent.

Moreover, using GAINS will also permit China to identify options to cut GHG emissions by 8 percent at no additional cost by 2030 (see figure above). As China is the world's biggest emitter of GHGs, limiting its GHGs is a crucial part of any national—and global—strategy to avoid dangerous climate change.

IIASA has also worked with partners in India to conduct a similar analysis for India. ■

Further information Amann M et al. (2008). *Scenarios for Cost-effective Control of Air Pollution and Greenhouse Gases in China.* GAINS ASIA Report.

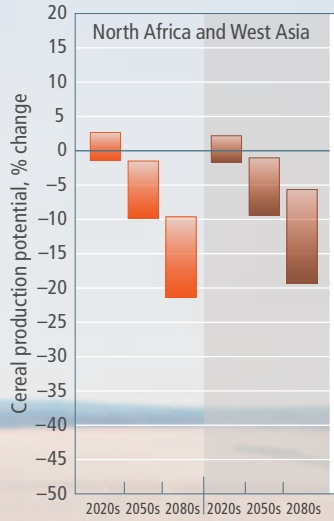
Further information GAINS is available free online at http://gains.iiasa.ac.at

Dr. Markus Amann is Leader and **Dr. Fabian Wagner** is Senior Research Scholar of IIASA's Atmospheric Pollution and Economic Development Program.

FEEDING THE WORLD IN 2050

Biofuels & climate change

CHALLENGES TO FOOD SECURITY IN THE TWENTY-FIRST CENTURY



New IIASA research shows that biofuels produced from food crops may have a greater impact on food security up to 2050 than climate change. While the impacts of climate change on the global food harvest are modest at first, global warming becomes a high risk by the middle of the century and beyond, as it starts to seriously harm arable land and water resources. However, at the same time, advances in technology will mean that biofuels can be grown on non-arable land, reducing competition with food production.

By 2050 the world will need to feed about 50 percent more people than in 2000. At the same time the world population will, on the whole, be wealthier and therefore demand—and be able to afford—more agricultural products, particularly more meat. The key to ensuring sufficient food in 2050 is to deliver a 70 percent increase in food production by sustainably intensifying agriculture through yield increases and multiple uses of the land. Increased investment and research to sustain such productivity growth is clearly essential.

HOW BIOFUELS & CLIMATE CHANGE WILL AFFECT THE WORLD'S FOOD
Future expansion of biofuel use will increase the global demand for crops, and climate change will eventually reduce crop yields and cereal production. The range of projected outcomes on the world food system shown here depicts a low-impact ("*a*"-columns) and a high-impact scenario ("*b*"-columns).

	2020s		2050s		2080s	
	a	*b*	*a*	*b*	*a*	*b*
Developed	– All values in million tons –					
Additional cereal demand for biofuel production	160	215	190	200	190	200
Climate change impacts on cereal production	60	–20	120	–65	85	–175
Aggregate impact	–100	–235	–70	–265	–105	–375
Developing						
Additional cereal demand for biofuel production	20	35	45	70	45	70
Climate change impacts on cereal production	30	–30	55	–115	–10	–250
Aggregate impact	+10	–65	+10	–185	–55	–320
World						
Additional cereal demand for biofuel production	180	250	240	260	240	260
Climate change impacts on cereal production	75	–40	140	–155	65	–420
Aggregate impact	–105	–290	–100	–415	–175	–680

NOTE "Additional cereal demand for biofuel production" represents various scenarios of biofuel expansion and the speed of developing second-generation biofuel technologies. "Climate change impacts on cereal production" examines the range of impacts through two general circulation models (Hadley Centre and CSIRO). It compares results that assume full agronomic adaptation and include CO_2 fertilization, to results that assume only limited agronomic adaptation and exclude CO_2 fertilization. "Aggregate impact" combines the impacts of biofuel production and climate change.

However, until recently it has not been clear what impact climate change might have on food production in the coming decades and whether climate change impacts would place an unbearable burden on food production or be relatively benign.

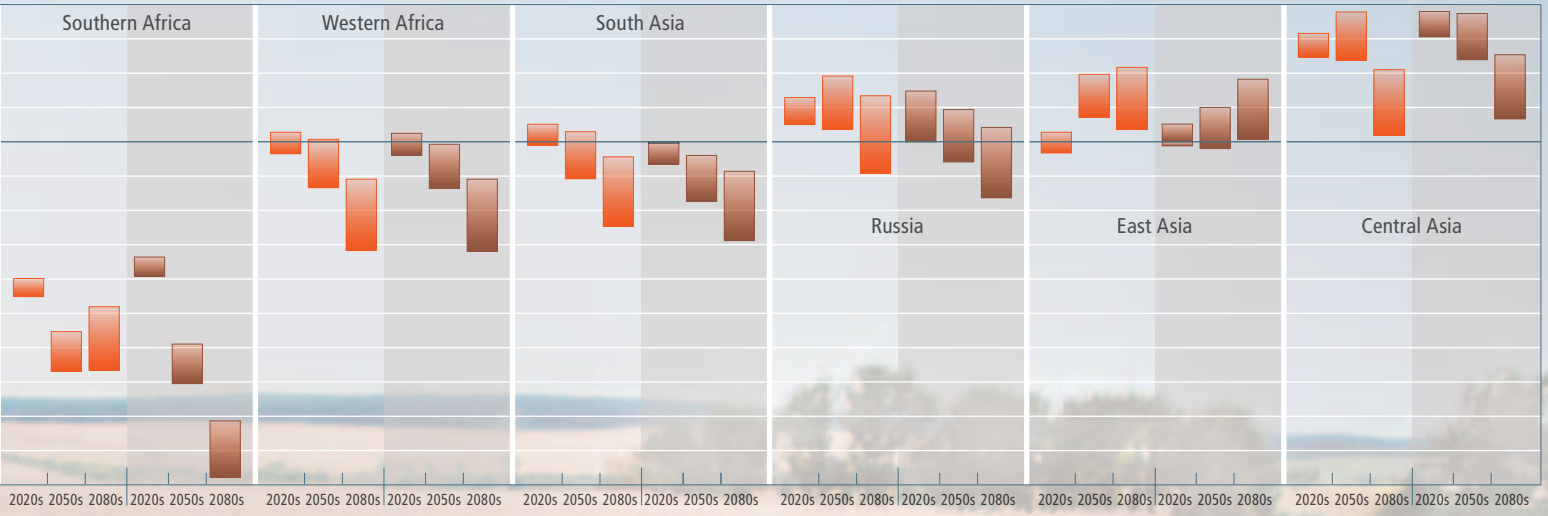
Global warming has the potential to boost food production in some parts of the world (e.g., Canada, Russia) and limit it in others (e.g., southern Africa). To understand how climate change can alter food production also requires an understanding of how the changing agriculture sector affects socioeconomic conditions, from food prices to consumption patterns, and how these in turn affect food production. Thorough systems analysis that examines all potential factors can provide such an understanding.

With this in mind, the United Nations Food and Agriculture Organization (FAO) turned to IIASA's Land Use Change and Agriculture Program to investigate the extent to which climate change and the expansion of biofuel production might alter the long-term outlook for food, agriculture, and resource availability. The findings have been used to inform international discussions at the highest level, culminating in the World Food Summit at FAO, held in Rome, Italy, 16–19 November 2009.

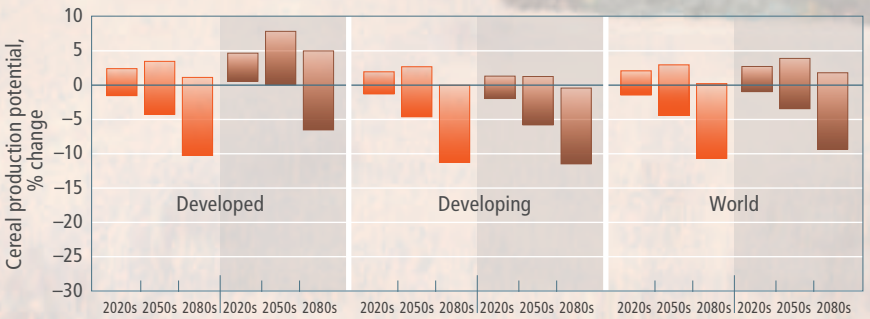
IMPACT OF CLIMATE CHANGE

At the global level, the research showed that the overall impact of climate change on food production would be relatively small in the period up to 2050, provided that the carbon dioxide (CO_2) "fertilization effect" materializes in farmers' fields—a beneficial effect expected to occur as concentrations of CO_2 in the atmosphere increase. For example, IIASA's work shows that if the CO_2 fertilization effect works and farmers are able to switch crops and select the most suitable for local climatic conditions, then the global production potential of rain-fed cereals on current cultivated land will actually increase somewhat, by about 3 percent by 2050. Without the fertilization effect and crop adaptation, the production potential is estimated to fall by 5 percent (lower chart, page 19).

However, this relatively benign picture on the global scale masks dramatic changes to the production potential of some world regions and food crops. For example, by using climate change spatial patterns of the UK Hadley Centre's general circulation model, the research shows that southern Africa will lose production of



UK Hadley Centre model
Commonwealth Scientific and Industrial Research Organisation (CSIRO) model



CLIMATE CHANGE AND REGIONAL FOOD PRODUCTION Results of climate change impacts on rain-fed cereal production are shown for two general circulation models (Hadley Centre and CSIRO). Each bar depicts a range of outcomes from a low-impact scenario (full agronomic adaptation, including CO_2 fertilization) to a high-impact scenario (limited agronomic adaptation, excluding CO_2 fertilization). Until 2050 the impact of climate change on global cereal production is relatively small, especially if farmers are able to adapt cropping patterns to the changing climate and benefit from CO_2 fertilization (lower chart). However, this benign picture hides major regional differences, with some regions losing considerable cereal production and others making large gains (upper chart). After 2050 the negative impacts of global warming on food production dominate.

rain-fed wheat, rain-fed maize, and rain-fed cereals by 44, 43, and 28 percent, respectively, by 2050. Central America, North Africa, and West Africa will also be hit hard by losses of cereal production. The world's production potential of wheat is likely to fall by some 5 percent by 2050; in some regions, such as sub-Saharan Africa and Central America, the production potential of wheat—a preferred ingredient in hundreds of food items from bread to beer to pizza—may fall by over 50 percent. In contrast, other crops such as maize or sorghum are likely to do well from climate change, which suggests not only that farmers must adapt their crops to climate change, but that people may have to adapt their diets as well.

The broadly balanced global picture of climate change impacts on food production until 2050 assumes agronomic adaptation by farmers and does not account for changed climate variability, which is expected to increase over the coming decades and may be an important destabilizing factor in the short-to-medium term. It also hides a far more worrying outlook beyond 2050. After mid-century, negative impacts of warming dominate, damaging the productive capacity of arable land, affecting water and biodiversity resources, and causing a rapid decrease in the crop production potential in most regions and in the global aggregate. The research estimates that cereal prices will increase by 20–40 percent by 2080, cereal production will fall by 4–7 percent in the developing world, and the number of people at risk of hunger will likely increase considerably, solely because of climate change.

IMPACT OF BIOFUEL PRODUCTION

In the nearer future, especially until 2030, the expansion of biofuel production poses a more serious challenge for the world food system. The impact will be particularly strong if the expansion continues to rely mainly on agricultural crops and reaches the levels and follows the rapid pace implied by the mandates and targets set in many countries.

First-generation biofuels—in other words, fuels produced from conventional agricultural crops (maize, sugar cane, cassava, oilseeds, palm oil, etc.)—accounted for approximately 80–85 million tons of cereals (4 percent of global cereal production) and 10 million tons of vegetable oil (7.5 percent of global vegetable oil production) in 2008. It may be appealing to justify biofuel targets in terms of enhancing fuel energy security and contributing to climate change mitigation and rural agricultural development; however, the reality is much more complex. Setting domestic biofuel targets at the national level has local, national, regional, and global impacts across interlinked social, environmental, and economic domains.

IIASA's simulations show that meeting ambitious biofuel targets with the production of first-generation biofuels may lead to substantially higher food prices: it reduces food consumption in developing countries, resulting in an increased number of people at risk of hunger—an estimated extra 40–130 million by 2020.

Second-generation biofuels, produced from woody or herbaceous non-food plant materials, have attracted great attention. However, the wide deployment of commercial plants of second-generation biofuels is unlikely to begin before 2020 because of the need to overcome substantial technological, logistical, and economic barriers. But once achieved, the research suggests that, even for ambitious biofuel targets requiring some 100 million hectares by 2050, land is available without having to compete with cultivated land or land needed for livestock grazing. Land for second-generation biofuel production is mainly available in sub-Saharan Africa and Latin America, as well as North America, Eastern Europe, Russia, and Central Asia. ■

Further information 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? Paper presented at the FAO Expert Meeting on How to feed the world in 2050, 24–26 June 2009, Rome, Italy.

Günther Fischer and **Harrij van Veltuizen** are Senior Scientists in IIASA's Land Use Change and Agriculture Program. **Mahendra Shah** is Advisor to the Director.

Climate change

Beyond the tipping points?

A growing number of scientists have begun asking what might be done to curb the negative impacts of climate change, particularly under worst-case "emergency" scenarios; the answer they keep coming back to is geoengineering.

Since the last Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC), a mounting body of evidence has suggested that climate change will, in fact, be more severe and more rapid than the median AR4 estimates. In particular, concerns about possible climatic "tipping points" have some climate scientists now talking about a possible "climate emergency" within their lifetime. Against this backdrop of scientific concern, global carbon emissions continue to accelerate (i.e., the rate of emissions increase is itself increasing).

Geoengineering schemes can be divided into two distinct categories—carbon dioxide removal (CDR) and solar radiation management (SRM). Both have the two main characteristics that define "geoengineering"—they involve intentional alterations to the climate system, and their impacts would be global (or close) in scale. Moreover, both have been the subject of major scientific review studies in 2009 led in part by IIASA's Jason Blackstock.

The first of these studies focused on schemes to inject sulfur aerosols into the stratosphere, which IIASA Institute Scholar and Nobel laureate Paul Crutzen drew considerable scholarly and public attention to in 2006 with a paper in *Climatic Change*. The new study report, released in July 2009 and lead-authored by Blackstock, found that while such techniques could cool the planet rapidly in an "emergency situation," there are very large uncertainties regarding the impacts on the climate of stratospheric aerosol injection. The report outlines a substantial program of further scientific research needed to improve our understanding of such aerosol options.

The second study currently being coordinated by Blackstock focuses on chemically engineered CDR techniques. The report, expected out in early 2010, will discuss why (similar to mitigation) such techniques would take decades to have significant climatic impacts. The study will, however, also highlight promising avenues for expanded scientific research.

These two review studies are also complemented by a third, conducted this year by the United Kingdom's Royal Society. Released in September 2009, the Royal Society's report provides a broad overview of all geoengineering schemes, and highlights the key differentiating characteristics of SRM and CDR techniques explored in detail by the other studies—most importantly: timescale of impact, and ability to effectively ameliorate greenhouse gas–induced climate change. Where SRM's rapid cooling effect with highly uncertain additional impacts make it a candidate response to a "climate emergency" scenario, CDR's slow but expected effective amelioration of climate change (because it removes the root cause) makes it more viable as a long-term complement to drastic carbon emission reductions, enabling eventual negative emission scenarios.

Of course, research into geoengineering does not occur in a vacuum. And as IIASA alumnus and Nobel Laureate Thomas Schelling pointed out in his 1996 *Climatic Change* article, serious consideration of geoengineering will impact nations' strategic perceptions and actions toward mitigation.

To begin addressing these issues, Blackstock is now organizing a series of side events at the UN Climate Change Conference in Copenhagen, as a partnership between the Royal Society, the Centre for International Governance Innovation, the International Institute for Sustainable Development, the Stockholm Environment Institute, and IIASA. These events will include short overview presentations of the science and governance challenges associated with geoengineering research, followed by panel discussions focusing on emerging issues. The two goals for these events are to encourage discussion of these issues among a broader community of policymakers and researchers and to promote global cooperation on the policy and governance dimensions of geoengineering research. ■

Further information A list of reference material is available online at www.iiasa.ac.at/Options/sources

Dr. Jason J. Blackstock is a Postdoctoral Research Scholar in IIASA's Risk and Vulnerability Program, and a Fellow at the Centre for International Governance Innovation (Waterloo, Canada).

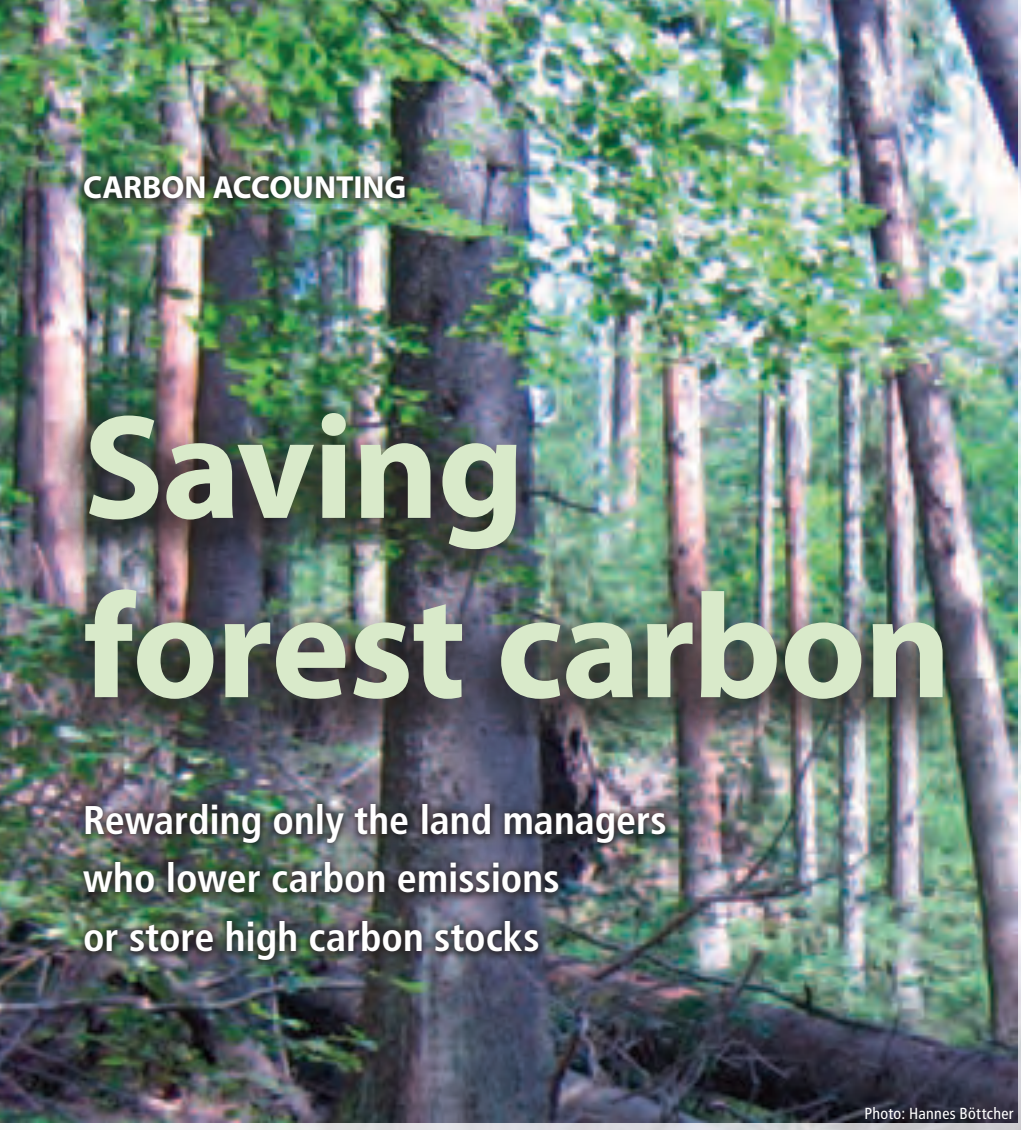


Photo: Hannes Böttcher

CARBON ACCOUNTING

Saving forest carbon

Rewarding only the land managers who lower carbon emissions or store high carbon stocks

IIASA researchers have designed and tested smarter rules to account for carbon that is absorbed and released through land management practices. The rules ensure that only practices that improve carbon management are rewarded—something that carbon accounting rules under the Kyoto Protocol have failed to do.

Any international climate change treaty, whether the Kyoto Protocol or a future agreement, needs a set of carbon accounting rules to determine how much carbon is not being released into the atmosphere as a result of climate-friendly activity. Carbon accounting is essential to incentivize countries, business, or people to take positive action to lower greenhouse gas emissions and to reward them accordingly.

However, setting carbon accounting rules in the land use, land use change and forestry (LULUCF) sector is complex. The rules need to consider not just how people's recent actions affect the amount of carbon a forest absorbs or releases, but also the impact of nature, climate, and, even more importantly, past practices.

The rules for forest management under the Kyoto Protocol account for the carbon balance of the ecosystem as it currently stands, but fail to distinguish what actually drives it. This leads to perverse incentives. For example, regenerating forests that have naturally high growth rates and are too young to be harvested absorb far more carbon from the atmosphere than they release, and are therefore rewarded under the Kyoto Protocol. However, old forests tend to contain high stocks of carbon and more frequently suffer natural disturbances, such as diseases or insect infestation, which release carbon from the forests. The Kyoto Protocol rules tend to penalize such forests.

Photo: Hannes Böttcher

PAST BEHAVIOR Carbon accounting should reflect both carbon absorbed by regenerating forests today and carbon released when areas were originally deforested.

NATURAL EFFECTS Natural disturbances drive the forest carbon cycle in many regions of the world. New rules can exclude such natural effects from carbon accounting.

Paradoxically, therefore, a country that has replanted forests it had previously overexploited is rewarded, whereas a country that has conserved its forests is penalized. Further, the carbon balance in both forest types is driven mainly by natural processes and therefore to a certain degree is predetermined. Thus land managers have relatively little influence. There are thus few incentives to improve current forest management practices.

To address such limitations, IIASA forestry researchers have tested and quantified the effects of alternative accounting rules. Their aim was to design rules that account for lower emissions and more storage of carbon and thereby provide incentives for improved management.

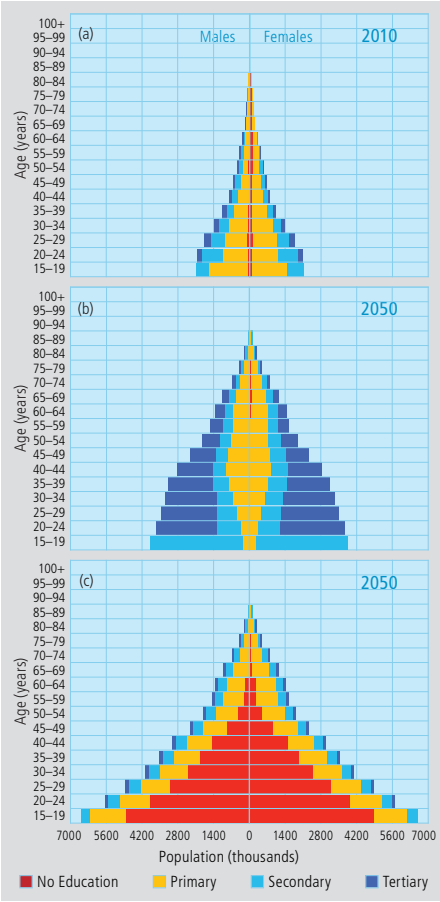
The researchers realized that they needed to isolate the effects that nature, climate, and past practices have on carbon stocks and emissions. They achieved this by building scientific modeling tools to calculate future carbon accounts for a reference scenario of a forest continually managed by a particular set of practices. The models were based on observations (e.g., forest inventory data), functions of tree growth, and assumptions on harvest rates.

By modeling and comparing different alternative management practices, the researchers were able to exclude natural and climatic effects and show only the effects of recent changes in management activity. Using this approach, a future international climate change agreement can ensure that rewards are issued only for management practices that increase stocks or lead to fewer emissions in comparison to the reference scenario. However, the challenge remains to design a robust and credible baseline for the reference scenario that would be agreeable to all countries. ■

Further information Böttcher H, Kurz WA, Freibauer A (2008). Accounting of forest carbon sinks and sources under a future climate protocol: Factoring out past disturbance and management effects on age–class structure. *Environmental Science & Policy* 11(8):669–686.

Dr. Hannes Böttcher is a Research Scholar in IIASA's Forestry Program.

EDUCATION AND POPULATION
Alternative scenarios for the population structure of Kenya by age, sex, and level of educational attainment for (a) 2010, (b) 2050, according to the rapid educational expansion scenario, and (c) 2050, according to constant enrollment scenario.



DEMOGRAPHY

Boosting education lowers population growth

Universal secondary education for females would result in a dramatically smaller increase in world population by 2050, according to IIASA. Population growth is one of the key drivers of greenhouse gas emissions; therefore slowing population growth will help slow climate change.

Research by IIASA's World Population Program examines the implications of different education policies on future fertility, mortality, and migration, and how this in turn affects both population and economic growth. Kenya has recently expanded school enrollment with a policy of free primary education, resulting in a population with the age, sex, and educational characteristics shown here in figure (a).

Looking toward 2050, if Kenya successfully implements a policy of rapid educational expansion, as implemented in Singapore, then IIASA research projects the population illustrated in figure (b). However, if Kenya simply maintains the current absolute level of enrollment, then its population size and composition in 2050 will be quite different, as depicted in figure (c).

The two different education scenarios lead to large differences in population growth. For instance, the size of the youngest age group, 0 to 5 years, is almost twice as large in the second scenario as under the pro-education first scenario. The high educational fertility differentials in Kenya explain the difference. In Kenya, for example, women with no formal education have on average almost seven children, while those with secondary education have only three.

The analysis is made possible by the new datasets developed jointly by IIASA and the Vienna Institute of Demography on educational attainment by age and sex for 120 countries back to 1970. The data also show that for developing countries a combination of universal primary education with broadly based secondary education leads to rapid economic growth, which has the potential to push countries out of poverty. ■

Further information Lutz W (2009). *Sola schola et sanitate*: Human capital as the root cause and priority for international development? *Phil. Trans. R. Soc. B* 364:3031–3047.

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

SYSTEMS ANALYSIS

Regreening the Sahel

Since the late 1960s recurrences of drought and famine in the African Sahel have cast it as a region helpless before the inexorable advance of the Sahara desert. However, reforestation over the past two decades in Niger's Maradi and Zinder regions has dramatically reversed these trends, securing the livelihoods of 4.5 million people.

This success has been ascribed to many individual factors, from increased rainfall to bottom-up community development. However, until recently, no study has systematically examined how all these individual factors interacted to produce these encouraging developments. Now, systems-analytical research by IIASA scientists has provided new insights, showing that the pattern of interactions has been more important to the sustained success of regreening than any single factor or process.

In the early 1980s, NGOs began helping local communities re-establish their autonomy in managing trees: first, they worked with local farmers to rediscover tree cultivation skills and second, they trained them in organizing tree management at a local scale. These governance changes saw Niger's farmers becoming more self-reliant at a time of national economic collapse and as the government moved against corrupt national forestry regulators.

By the mid-eighties rumors about the Sahara smothering the region, along with fear of famine and mass migration, pushed farmers to try new strategies. When an international NGO encouraged experimental farming practices with a food-for-work program to relieve the 1985 famine, farmers rushed to try new practices. One practice, reforestation, previously discouraged by colonial powers, soon reached a critical mass. Now, as the trees cut field wind speed, farmers no longer have to replant their crops several times over.

"Thus vicious circles turned to virtuous circles," explains IIASA's Jan Sendzimir, "as increased food production led to more profitable sales and reduced social tension. Farmers and their communities learned and enforced better practices, built better relations with herders to increase livestock-mediated fertilization of fields, increased their regional access to information, seeds, grazing lands, and jobs, and gradually increased their autonomy. The entire social-ecological system has flourished at all levels and decreased farmers' vulnerability to natural or social sources of uncertainty." ■

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

Dr. Jan Sendzimir is a Research Scholar in IIASA's Risk and Vulnerability Program.

Photo: USAID | Conservation International

UNDERSTANDING VULNERABILITIES

From boom to bust: Mexico's coffee farmers

During the 1980s Mexico's share of the world coffee exports grew to 6 percent, making it the world's fourth-largest coffee exporter. However, a severe frost in late 1989 followed by the implementation of land privatization at a point when world coffee stocks were at a high started a chain of reactions that saw Mexico's share of coffee exports tumble to 2.7 percent by 2003/04.

Investigating the vulnerabilities of coffee farmers in both Mexico and Vietnam, sociologists Hallie Eakin of Arizona State University, USA, and Alexandra Winkels of the University of East Anglia, UK,asked IIASA's Jan Sendzimir to provide a broader systems analytical perspective. Together they identified how multiple interconnected factors at international, national, regional, and local levels shape the livelihoods of coffee farmers in Mexico.

The Mexican government's drive to expand coffee production in the 1980s had encouraged farmers to expand coffee plantations and stop growing alternative cash crops such as sugarcane and subsistence crops. But in the early 1990s, the government withdrew state support for coffee farmers leaving farms saddled with debt and no alternative income. Further, labor was scarce and relatively expensive. Poor harvests had reduced demand for coffee workers and, as a result of this and other factors, growing numbers of young Mexicans were leaving in search of employment in northern Mexico and the United States.

Thus, when the high productivity of Vietnamese coffee farmers contributed to an oversupply of coffee and the collapse of world coffee prices, the resilience of Mexican farmers to external shocks was low. Because of the high cost of labor relative to market prices and the cutbacks in agricultural investment and maintenance of coffee plantations, farmers responded by leaving 50 percent or more of their harvest on the trees. Demand for labor fell further and a crisis in rural livelihoods ensued.

Regarding the systems analytical contribution he made to the research, Jan Sendzimir says: "Elinor Ostrom, the first female winner of the Nobel Prize for Economics, has shown that research must not be bound by any single discipline or level of analysis. Our research highlights that policies which aim to address people's vulnerabilities must be based on an improved understanding of multiple factors from different disciplines, their linkages, and feedbacks at multiple scales." ■

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

Dr. Jan Sendzimir is a Research Scholar in IIASA's Risk and Vulnerability Program.

THE HUMAN CARBON BUDGET

Carbon accounting of humans in the United States

Considerable research has been conducted on the impacts on carbon dioxide emissions of individual lifestyles and government policies. However, relatively little work has been done on the absorption and emission of carbon by the human body.

In 2008, while spending a sabbatical year at IIASA, Dr. Gregg Marland collaborated with scientists at the Oak Ridge National Laboratory in the United States to study how people in that country are using, storing, and transporting carbon in their own bodies and to quantify these levels.

The work, recently published in the journal *Biogeochemistry*, found that the average adult (aged 15–39) in the USA contains about 21 kg of carbon. Each year the adult consumes about 67 kg of carbon and releases 59 kg as expired carbon dioxide, 7 kg of carbon in feces and urine, and less than 1 kg of carbon as flatus, sweat, and aromatic compounds.

The amounts are not negligible when scaled up to a national level. The human body is displacing and releasing an amount of carbon equivalent to nearly 12 percent of per capita fossil fuel emissions in the USA.

"Understanding and quantifying the human carbon budget helps improve our knowledge of carbon sources and sinks, which is vital to combat climate change," says Dr. Marland. "Our research also showed how humans alter the spatial distribution of carbon emissions. Most carbon is released by humans in densely populated areas, whereas the carbon the body consumes is initially absorbed from the atmosphere by agricultural crops in rural areas." ■

Further information 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* 94:29–41.

Dr. Gregg Marland was a Research Scholar at IIASA from June 2007 through May 2008.

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BIODIESEL PRODUCTION COSTS

Emission omissions

Can biodiesel help cut emissions in the Indian transport sector?

Diesel is a major fuel source in India, with 71 percent of the oil consumed in 2005 being diesel and 29 percent gasoline. Given that India's fuel consumption of 12 million tonnes per annum in the transport sector alone is expected to double by 2030, India and other developing countries are urgently seeking cheap and environmentally friendly alternatives to meet future energy demand.

A recent study by IIASA's Forestry Program, published in the journal *Applied Energy*, demonstrates that biodiesel, which produces significantly fewer emissions than regular diesel, can be produced cost-effectively in India from the plant *Jatropha Curcas*, a drought- and pest-resistant perennial that grows in tropical wastelands and produces seeds for up to 50 years. *Jatropha* could potentially produce 150,000 tonnes of cheap and renewable diesel for Indian vehicles per year.

Importantly, *Jatropha* does not compete with food crops for land; instead, it potentially offers opportunities to poorer Indian farmers to use wasteland to increase their income. By-products of biodiesel production, for example, oil cakes and glycerol, can also be used in the fertilizer and cosmetic industries, respectively.

Jatropha seeds have a 37 percent oil content that needs minimal refining before use. As *Jatropha* biodiesel is very similar to diesel itself, little modification to current engines is required. Vehicles can run on pure biodiesel or any bio/mineral diesel mix. Compared to mineral diesel, pure biodiesel cuts emissions of black carbon or "soot" by 60 percent, carbon monoxide and hydrocarbons by 50 percent, and greenhouse gases by 80 percent. Sulfur dioxide emissions are nil, given the vegetable origin of *Jatropha*; however, the combustion characteristics of the engine used could increase or decrease nitrous oxide emissions by up to 10 percent.

With Luleå University of Technology in Sweden, IIASA modeled 40 million hectares of Indian wasteland across 24 states to determine the number and locations of potential biodiesel production plants that would be optimal for fuel production. The analysis revealed that biomass cost was the most important factor affecting overall biodiesel production cost, followed by investment and transportation. One result of the emissions analysis was that poor *Jatropha* plant yield at any location could result in raw materials needing to be transported to the production plant, increasing financial costs and emission levels. While overall findings show that, based on the costs of production and the emissions released, an appropriate number and specific locations of biodiesel plants can be determined, further research is required on the economies of scale involved.

The use of *Jatropha* for biodiesel production, while significant, is limited to tropical countries. Previous FOR research has shown that methanol derived from poplar trees can be a viable biofuel alternative to gasoline in Austria, while ongoing research is looking at the potential for using a variety of other plant types (such as maize or canola) as biofuel production sources in other non-tropical regions. ■

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JATROPHA CURCAS Currently, the oil from *Jatropha Curcas* seeds is used to make biodiesel fuel in the Philippines and Brazil. In India a train powered by 15–20 percent *Jatropha* biodiesel connected two of its largest cities in 2007. In 2008 a Boeing 747 Air New Zealand carrier became the world's first successful test flight on *Jatropha* biofuel.

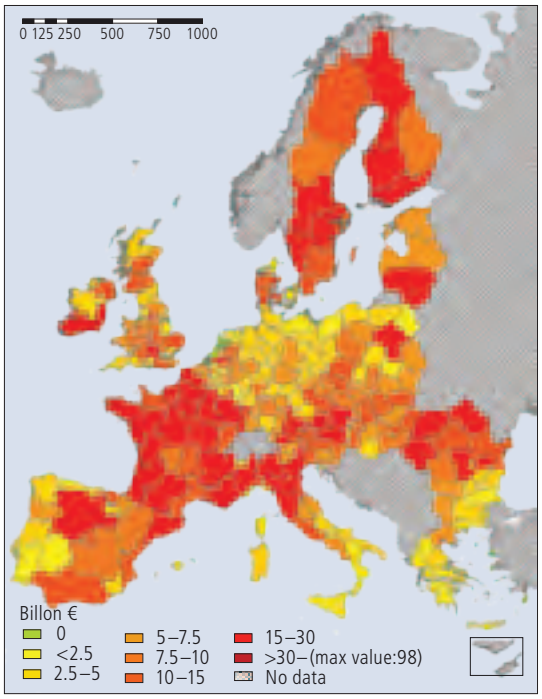
Further information Leduc S, Natarajan K, Dotzauer E, McCallum I, Obersteiner M (2009). Optimizing biodiesel production in India. *Applied Energy* 86(1):125–131.

Dr. Sylvain Leduc is a Research Scholar in IIASA's Forestry Program.

FINANCIAL RISK MANAGEMENT

Preparing Europe for more floods and droughts

COSTS OF FLOODS IN EUROPE
The map quantifies the monetary cost of a flood that is likely to happen once every 100 years.



Governments across Europe need better financial planning to deal with the consequences of increasing extreme weather events that are expected to result from global and climatic changes, according to recent research from IIASA. The research was part of the ADaptation And Mitigation Strategies (ADAM) research project and funded by the European Commission.

For ADAM, IIASA generated the first European-wide, probabilistic maps of the monetary risks associated with floods and droughts. The maps offer a unique combination of data on an area's vulnerability, exposure to risk, and the degree of hazard it faces in order to estimate the potential monetary losses. The areas most vulnerable to drought (e.g., agriculture in southern Europe) and to floods (e.g., Eastern Europe) can then be identified (see map).

According to the research, prudent financial planning is essential to avoid fiscal crises in the aftermath of large-scale disasters. IIASA's Reinhard Mechler, who led this part of the research, points to the Austrian political and fiscal "crisis" following the large-scale flooding in 2002. "Governments need to make sure they set aside sufficient funds for disaster relief and reconstruction in their budgets," he says.

Many governments faced with such crises in recent years have turned to the €1 billion per year European Union Solidarity Fund, established to provide financial aid in the case of severe natural disaster–related losses. Yet, as Stefan Hochrainer, another IIASA researcher working on ADAM, concludes: "This fund will need to be increased in future, as we expect more states to be facing worsening drought and flood problems." ■

Further information www.adamproject.eu

Dr. Stefan Hochrainer and **Dr. Reinhard Mechler**, from IIASA's Risk and Vulnerability Program, collaborated with international research partners in the ADAM project.

RENEWABLE ENERGY

Germany scores high in the European solar league

From the source to the consumer, energy is a system that can be comprehensively modeled in all its forms and from every angle. Recent research by IIASA and partners from the University of Freiburg in Germany used advanced modeling to uncover the optimal European countries for renewable energy, with interesting results. The area studied was confined to Europe, and country resolution was chosen because most energy decisions are made at country level.

There were problems to solve before modeling began. The first involved data quality and model suitability, which was addressed by using highly accurate, high-resolution data from remote sensing (RS) as an input to modeling—the *QuickBird* satellite, for example, offers 0.61 m spatial resolution which allows for a very precise assessment of renewable energy potential.

The second problem was the lack of mature modeling methods for estimating renewable energy potential. Thus, as a "catch-all," three different modeling approaches—geographical, technical, and economic potential—were integrated with the RS data. The models ran individually, and were also bridged so that results could be exchanged, while a feedback mechanism provided delivery of the final results.

Solar energy was used as a case study for illustration in this case. The BEWHERE model was implemented to determine the optimal locations to install new renewable energy plants by minimizing the system cost. This consisted of analyzing 2004 data on different aspects of solar energy in European countries, including such parameters as installed photovoltaic (PV) capacities (plants and individual homes), spare PV capacity, the amount of solar irradiation, PV module price, electricity trade price, and electricity demand.

Based on the IIASA/University of Freiburg assessment and according to the parameters modeled, Germany was found to be a leading European country for solar energy. ■


Solar panels in Bavaria, Germany

Further information Wang S, Leduc S, Wang S, Obersteiner M, Schill C, Koch B (2009). A new thinking for renewable energy model: Remote sensing-based renewable energy model. *International Journal of Energy Research* 33(8):778–786.

Dr. Sylvain Leduc is a Research Scholar in IIASA's Forestry Program.

IIASA-hosted database proves a hit with researchers

Since August 2009, more than 16,000 visitors have viewed data from the "Representative Concentration Pathways" database, which will be used for the forthcoming climate projections of the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), due for publication in 2013. All data can be downloaded free of charge, subject only to provision of an e-mail address.

FUTURE GREENHOUSE GAS EMISSION DATA The Reforming Economies region is selected under three scenarios to show levels of sulfur emissions from international shipping to 2100. Note that the data include chart preview and tabular data.

MAPPING FUTURE GREENHOUSE GAS EMISSIONS Spatial data for CO emissions under the low RCP scenario are shown for the year 2050 and available at decadal intervals.

The newly launched database, hosted at IIASA is the result of several years of collaboration between internationally renowned scientific teams coordinated by the Integrated Assessment Modeling Consortium. The database including projections by IIASA and two (soon to be three) partner institutions, is unique in providing global coverage for both sectoral and spatial detail for greenhouse gases (GHG) and air pollutants. A work in progress, it currently includes harmonized emission pathways starting from an identical base year (2000) for BC, OC, CH_4, Sulfur, NO_x, VOC, CO, and NH_3. Harmonization of well mixed GHG emissions and concentrations is under preparation, and the database is also being extended with historic and harmonized future land use/land use cover data, historic emissions, and extension of selected variables for the 2100–2300 period.

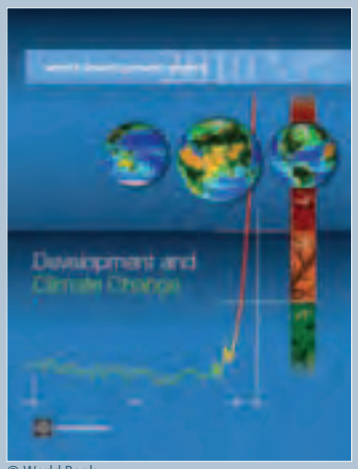
The database includes a number of user-friendly features. The different scenarios (RCPs) underpinning the climate simulations of the AR5, can be viewed and compared on-line at the level of five world regions, 13 sectors as well as spatial maps with a resolution of 0.5° × 0.5°. The four RCPs were selected based on their radiative forcing characteristics of GHG and other climate-forcing agents, showing different scenarios from low to high concentration levels at a decadal scale.

The data, which have undergone several procedures to assure quality and consistency, can be downloaded in various formats, including Microsoft Excel, scalable vector graphics, and netCDF format.

The three RCPs currently available were developed by the IMAGE modeling team of the Netherlands Environmental Assessment Agency, Pacific Northwest National Laboratory's Joint Global Change Research Institute, and IIASA's MESSAGE Modeling Team and Integrated Assessment Framework. ■

Further information The RCP database is available at: www.iiasa.ac.at/web-apps/tnt/RcpDb

Dr. Keywan Riahi leads the IIASA research team developing one of the RCP databases.



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IIASA contributes to World Development Report 2010

IIASA research in climate change, energy perspectives, and adaptation and vulnerability, are reflected in the World Bank's World Development Report 2010, entitled *Development and Climate Change*. The report, released ahead of the UN Climate Change Conference in Copenhagen, states that if advanced countries act now to reduce their carbon footprint and adopt alternative energy sources it will be economically feasible to tackle climate change. Deputy Director of IIASA, Nebojsa Nakicenovic, was on the Panel of Advisors for the Report, which was released in late October.
www.worldbank.org/wdr

International Energy Conference

"Towards an Integrated Energy Agenda Beyond 2020," the report of the Vienna Energy Conference 2009, has been published by the United Nations Industrial Development Organization (UNIDO). Held on 22–24 June in Vienna, the conference was organized by UNIDO, the Austrian Government, and IIASA. The report offers six recommendations, including energy development goals for 2030: energy efficiency, accelerating energy research and development, the diffusion of energy technologies, strengthening UN energy, and global energy support.
www.viennaenergyconference.org

Negotiated Risks

The latest publication from IIASA's Processes of International Negotiation Program, *Negotiated Risks* fills a major gap in the literature by bringing together two research strands: issue-driven risks, like climate change; and actor-driven risks, where a leading actor may help get a negotiation process out of an impasse or make a stalemate more hurting to other parties. *Negotiated Risks* contains detailed theoretical perspectives backed by case studies on climate change, weapons of mass destruction, the Cuban Missile Crisis, joint ventures in China, and the challenges of nuclear energy use.
Avenhaus R, Sjöstedt G (eds) (2009). *Negotiated Risks: International Talks on Hazardous Issues.* Springer, Heidelberg, Germany.

Technological Innovation

The book, which brings together some of the papers presented at the IIASA–Tokyo Tech meetings from 2002 to 2006 at IIASA, offers an interesting blend of applied state-of-the-art studies of coevolutionary development of institutions, innovation diffusion, and innovative entrepreneurship, not published anywhere else. It has a wide geographic scope, including China, India, Japan, the Netherlands, and the United States, with many cross-country comparisons.
van Geenhuizen M, Watanabe C, Jauhari C, Masurel E (eds) (2009). *Technological Innovation Across Nations: Applied Studies of Coevolutionary Development.* Springer, Heidelberg, Germany.

Urban flooding: Reducing vulnerabilities

The latest IIASA Research Report, published in October 2009, describes an interdisciplinary approach to flood risk analysis and management, developed by IIASA's Risk and Vulnerability Program, and focuses on investigating flood risks in the city of Vienna, Austria, with case studies of urban flooding in South Korea, Taiwan, and the United States. The study suggests alternatives for combining different mitigation measures as part of an overall strategy to decrease total mitigation costs and reduce the likelihood and uncertainties of catastrophic financial losses.
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.

Princeton Guide to Ecology

In his new book, "The Princeton Guide to Ecology," IIASA Vice-Chair, Simon Levin, has tapped more than 130 experts to compile a concise, authoritative one-volume reference to the major subjects and concepts in ecology. The 850-page book is intended for undergraduate and graduate students, research ecologists, scientists in related fields, and policymakers, along with anyone who wants an introduction to aspects of ecology.
http://press.princeton.edu/titles/8879.html

For more IIASA publications, visit IIASA's online publications catalog at www.iiasa.ac.at/Publications

CAPACITY BUILDING

IIASA programs for young scientists and postdocs

IIASA is now accepting on-line applications for the 2010 Young Scientist Summer Program (YSSP) and the Postdoctoral Program. The YSSP offers advanced graduate students from around the world the opportunity to spend the summer of 2010 working in an international and interdisciplinary research environment on projects related to their own doctoral research. IIASA is also offering scholarships for postdoctoral researchers to spend 12 to 24 months working at IIASA on areas relevant to the Institute's research agenda. The application deadline for the YSSP is 18 January 2010 and for the Postdoctoral Program is 28 February 2010. ■

www.iiasa.ac.at/yssp
www.iiasa.ac.at/postdocs

Photo: Linda Kneucker | IIASA Society

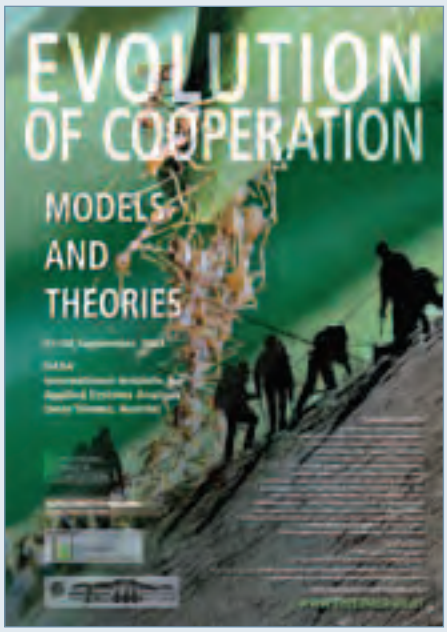

Peter de Janosi

IIASA SOCIETY

IIASA hosts alumni/ae

Forty IIASA alumni/ae attended IIASA Alumni/ae Day 2009, held at IIASA on 22 October. The event included presentations by Jill Jäger on "Environmental change and forced migration" and by Landis MacKellar on "Health modeling: Some postmodern thoughts." Peter de Janosi (IIASA Director, 1990–1996) was designated as the first Honorary President of the IIASA Society. An introduction to IIASA's newly established endowment fund was given by IIASA Director, Detlof von Winterfeldt. The event was organized by the IIASA Society in collaboration with IIASA; it concluded with IIASA's traditional international dinner. ■

www.iiasa.ac.at/IIASA_Society
www.iiasa.ac.at/ief



EVOLUTION AND ECOLOGY

Cooperation conference

IIASA organized and co-hosted an international Conference on the Evolution of Cooperation—Models and Theories on 15–18 September, as part of the European Science Foundation's Evolution of Cooperation and Trading Programme. Some 130 scientists from 15 countries attended. ■

STAY IN TOUCH

IIASA launches e-newsletter

Giving partners, collaborators, the public, and staff regular updates on the latest research activities at IIASA is the aim of a new electronic newsletter. Produced every two months, the IIASA Newsletter will complement other IIASA public information services, such as the Web site and the magazine, *Options*. ■

www.iiasa.ac.at/newsletter

IIASA GAINS

Barcelona climate talks

On 3 November IIASA's Markus Amman and Fabian Wagner held a side event at the UN Barcelona Climate Change Talks, entitled "Mitigation potentials, pledges and costs of Annex I countries in view of the economic crisis." Presentations compared evaluations from various models of current pledges by governments on reducing greenhouse gas emissions (see page 16), and how these are influenced by assumptions on future economic development. ■

CLIMATE CHANGE

UN Leadership Forum

Nebojsa Nakicenovic, Deputy Director of IIASA, participated in the UN Leadership Forum on Climate Change in New York on 22 September by invitation of the UN Secretary-General Ban Ki-moon. The Forum, attended by world leaders in government and business, aimed to identify solutions for climate change mitigation, and adaptation ahead of the negotiations at the UN Climate Change conference in Copenhagen in December. ■

EXTREME EVENTS

Kyoto conference

The 9th IIASA–DPRI FORUM on Integrated Disaster Risk Management, organized by the Disaster Prevention Research Institute of Kyoto University (DPRI) in collaboration with IIASA took place at Kyoto University, Japan, from 12–16 October. IIASA Director, Detlof von Winterfeldt, gave a keynote speech on "The Challenges of Extreme Events and Systemic Risks." ■


Maurice Strong

SYSTEMIC CRISES

Maurice Strong lecture

Leading environmentalist Maurice Strong gave a presentation on "Systemic Response to Systemic Crises" at the Vienna Diplomatic Academy of Vienna on 7 June 2009 as part of IIASA's Young Scientists Summer Program. ■

MEDIA MATTERS

Where IIASA is making the news

This new addition to *Options* provides a brief overview of the main areas of IIASA research attracting media attention. In the past five months IIASA has been quoted or referred to in the media of 35 countries, most notably Austria, the United Kingdom, and the United States. Media coverage has focused on many aspects of IIASA research, primarily that which relates to climate change, energy, ecology & evolution, and population, as the following examples show.

Climate change

▶ A press release on the **GAINS** analysis of the costs to Annex 1 countries of meeting their greenhouse gas emissions "pledges," achieved media coverage in France, Germany, the Netherlands, New Zealand, the United Kingdom, and the United States.

▶ Following an interview with *Reuters* on **population growth** in the USA and on that country's ability to achieve significant cuts in **greenhouse gas emissions** by 2050, IIASA received significant media coverage, including: *Reuters Business*, *Planet Ark*, *Reuters Economique*, *The Economic Times* (India), *The Peninsula Qatar*, *Emirates Business*, and *TV New Zealand*.

▶ A report on **geoengineering**, led by IIASA and published by Novim, on the research needed to understand the potential costs and benefits of undertaking climate manipulation through geoengineering, attracted significant media attention, including *Science*, *Nature*, the *New York Times*, *Bloomberg*, *National Geographic*, *Die Presse*, *The Daily News*, *Nature News*, and the *World Business Council for Sustainable Development*.

▶ IIASA research on **risk and insurance**, primarily that associated with the Munich Climate Change Insurance Initiative, was profiled in *Nature*.

Energy

▶ The **International Energy Conference**—co-organized by IIASA, UNIDO, and the Austrian government—attracted media attention in 15 countries. The primary messages carried by the media were the strong link between energy access and poverty and that, given the requisite political will, both issues could be resolved. The link between job creation and renewable energy was also reinforced.

▶ The **potential of renewable energy**—solar arrays in particular—continues to attract attention, with IIASA quoted in a range of media including: *New Scientist*, *The Times* and *The Sunday Times* (London), *Contre Info France*, *Irish Independent*, *Tehran Times*, *The Statesman*, and *The Huffington Post*.

Ecology & evolution

▶ Following publication of an article in *Science* and an accompanying press release on the discovery of **universal rules for food-web stability**, IIASA is quoted in various media including: *Science Daily*, *News Guide US*, *NDTV News India*, *Genetic Engineering and Biotechnology News*, and *Der Standard*. Research in fisheries-induced evolution continues to receive coverage, while the international conference "Evolution of Cooperation—Models and Theories," organized by and held at IIASA, received very positive coverage in the Austrian press.

Population

▶ IIASA research on **population projections and human capital** was quoted broadly, most notably in the *New York Times*, *The Economist*, *World Watch Washington*, *Scientific American*, the *Lancet*, and *Austrian radio ORF*. *The New York Times*, *International Herald Tribune*, *Financial Chronicle*, and *The Hindu* ran features on technology adoption quoting IIASA population projections.

▶ The award to Vegard Skirbekk of the **European Starting Independent Researcher Grant** by the European Research Council received coverage in Austria, Germany, and Norway. ■

www.iiasa.ac.at/Admin/INF

in the news

Bloomberg • Contre Info France • Der Standard • Die Presse • Emirates Business • Financial Chronicle • Genetic Engineering and Biotechnology News • International Herald Tribune • Irish Independent• Lancet • National Geographic • Nature • Nature News • NDTV News India • New Scientist • New York Times • News Guide US • ORF • Planet Ark • Reuters • Reuters Business • Reuters Economique • Science • The Hindu • Science Daily • Scientific American • Tehran Times • The Daily News • The Economic Times (India) • The Economist • The Hindu • The Huffington Post • The Peninsula Qatar • The Statesman • The Times (London) • The Sunday Times (London) • TV New Zealand • World Business Council for Sustainable Development • World Watch Washington

partnerships

When friends from the Potsdam Institute of Climate Impact Research (PIK), Carlo Jaeger and Antonella Battaglini, invited IIASA's Anthony Patt to a Berlin workshop to explore the use of concentrating solar power (CSP) technology for the Europe/Middle East/North Africa (EU-MENA) region, he enthusiastically headed north…

RESEARCH COLLABORATORS

Potsdam Institute of Climate Impact Research (PIK) Antonella Battaglini (*left*), Ottmar Edenhofer, Carlo Jaeger, and Johann Lilliestam
University of Oldenburg, Germany Bernd Siebenhüner
IIASA Kerstin Damerau, Nadya Komandantova, Lin Fan, Anthony Patt (*right*), and Keith Williges

What is Concentrating Solar Power?

Concentrating solar power (CSP) technologies use mirrors to reflect and concentrate sunlight on to receivers that collect the solar energy and convert it to heat. This thermal energy can then be used to produce electricity via a steam turbine or heat engine driving a generator.

CSP technology has been around for decades, but after a brief spurt of investment in the late 1980s, has seen no growth—probably because it only really works in desert climates and in the last decade, most motivation for renewable energy has been from northern countries. Suddenly CSP is exciting again, being perhaps the only renewable technology that can be scaled up enough to satisfy a large share of global energy demand. Unlike solar photovoltaic and wind,it is not intermittent; however, long transmission lines are needed from unpopulated desert locations to populated places. ■

However, at the Berlin workshop he was struck by the realization that development of CSP in EU-MENA could be stalled by certain perceived risk and risk management problems. These were under-researched, Patt told Battaglini, and perhaps a joint IIASA/PIK approach was needed to look at them.

There followed a major effort on the part of Patt and Battaglini to put together a team of the caliber needed for the research. Patt, currently co-leading an externally funded project addressing risk perceptions and risk management behavior among investors in renewable energy generally, decided to focus that work on CSP in the EU-MENA region and assigned a postdoctoral researcher to conduct empirical research with stakeholders on risk issues.

Funding the work involved careful housekeeping, and still does, but some money came in for two projects from the newly established European Climate Foundation (ECF), whose Director Battaglini and Patt had met at the 2008 Tällberg Forum. In summer 2008 two new team members began developing a model to estimate the costs of alternative CSP scenarios. By summer 2009 an IIASA YSSP participant was comparing investment in CSP and coal under conditions of policy uncertainty and in October, a new PhD student from BOKU, Vienna, came to IIASA to reinforce the team.

On the overall CSP front, meanwhile, things were humming, with IIASA and PIK being invited to supply technical expertise to the Mediterranean Energy Observatory (OME) in late 2008, and to the Desertec Industrial Initiative, a group of large German companies in summer 2009. The team was also asked to help PriceWaterhouse to put out a policy report for the UN Climate Change Conference in Copenhagen. ECF is now funding an initial assessment of the development of an EU strategy for achieving complete power sector decarbonization by 2050, to which PIK and IIASA are contributing.

The IIASA–PIK collaboration represents a dovetailing of different strengths and disciplines, built on respect and trust. While Patt studies decision making under uncertainty, Battaglini is an MBA and an excellent networker. "She figures out what kinds of research and input various business actors actually need," says Patt, "and together we work out the research design."

According to Battaglini, Patt excels at writing, especially papers for academic conferences and peer-review. "He makes sure that our research can be presented in a way that is acceptable for academic audiences, while I lead on the stakeholder side," she says.

Communication is mainly by e-mail and phone, with twice-a-month face-to-face meetings, mainly at PIK. In 2010 travel within Europe and a workshop in North Africa are on the cards. Advised by Battaglini, Patt has just made a presentation on CSP, to the chief investment officer of a large asset management company which directs billions of dollars of private and sovereign investment. From being a small glimmer on the desert horizon, says Patt, "the possibilities for CSP are now huge." ■

Detlof von Winterfeldt

IIASA director and ambassador, professor, and ocean kayaker

It is tempting to call Detlof von Winterfeldt IIASA's "new" Director. However, an astonishing ten months have passed since he and his family left their southern California home in Laguna Beach for Laxenburg. So why on earth would anyone swap a palm-fringed strand and vibrant Pacific sunsets for an eighteenth-century Habsburg village with a wind that blows straight off the Russian steppes?

"I want to inject fresh energy into IIASA and help bring a new focus and outlook to our research" Detlof von Winterfeldt says. "And," he adds with a smile, "it's only a five-minute walk to work here instead of 90 minutes on the L.A. freeway to USC!"

USC is the University of Southern California, where he is a "double" professor of Industrial and Systems Engineering and of Public Policy and Management. He maintains contact with his departments while on leave of absence at IIASA, getting up at seven every morning to answer an average daily accumulation of 50 e-mails from USC staff and students nine time zones away before arriving at IIASA at 8.30 a.m.

The first hour of work at IIASA is always reserved for responding to urgent IIASA e-mails and getting organized, and by 9.30 a.m. he is ready to face the day. To date, his work has entailed many meetings and conferences regarding IIASA's new 2011–2020 Strategic Plan, *Research for a Changing World*, the implementation of which is currently being finalized. Steering IIASA forward from the somewhat becalmed waters of the old research plan into the choppier intellectual seas and more demanding research currents stirred up, among other things, by the 2008 economic crisis, is exciting for him. So, too, is his ambassadorial role for IIASA—the meetings, receptions, and dinners he attends with the diplomatic corps, not just to solicit new members, but also to raise awareness of the tremendous contribution of IIASA, actual and potential, to solving global problems.

Professor, Director, Ambassador.... Is Herr von Winterfeldt ever off-duty and how does he spend his free time? He smiles ruefully, as if to say "what free time?" He reads avidly when he can—German and English literature. But he'd like to slot in a little fitness training between his trips to countries interested in IIASA membership, the dinners, the long working hours, and the two highly interactive classes he teaches on decision analysis three times a semester at the London School of Economics.

"I used to work out three times a week in L.A.," he says. "And when I go on holiday, I always try to do a spot of ocean kayaking. We need a gym at IIASA," he muses. "Certainly, I'd use it every day. The only problem is where to put it...." ■

At an ambassadorial reception, IIASA's Director and his wife greet the Indian Ambassador to the International Organizations in Vienna and his wife

A day in the life of the IIASA Director

7.00	Straight from bed to the computer to check e-mails from L.A.
8.30	Arrive at office to deal with IIASA e-mails
9.30	Management meeting
10.30	Meeting with one of the internal committees of the Institute
11.30–12.15	Administration and phone calls
12.15–14.00	Lunch with colleagues or visitors to the Institute
14.30–16.00	Review internal matters, documentation, strategic-plan-related business
16.00–17.30	Meetings with program leaders; interviews with press
20.00	Ambassadorial dinner in Vienna

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