Clearing the Arctic air
IIASA researchers explore how to reduce the black carbon pollution that is contributing to a warmer Arctic

IIASA tackles the Tropics
A new multi-year flagship project will explore the challenges facing Earth’s tropical regions

In the human interest
A revolutionary project explores how climate change will affect the human race
Food for thought

We have a tradition at IIASA of celebrating the American holiday of Thanksgiving. Every year the most recent North American to join us stands up before lunch to remind us of the origin of the feast—said to date back to 1621 in Plymouth, Massachusetts—which was thankfulness for a good harvest and the means to survive another winter. The plenty that many of us enjoy should not let us forget the poor, in developed and developing countries alike, who will not have enough to eat or drink because of sickness, failed harvests, lack of water, and other social ills. However the challenge of providing food more equitably now and in the future brings about many questions across a large variety of scientific themes and economic sectors.

In this issue you will read about IIASA’s expansive research into the impacts of food production and consumption, which spans at least three of our research programs and is tied closely to the environment, water, and climate change (page 14). You will also find the latest on our joint effort with researchers worldwide on a model intercomparison study to better quantify the impacts and uncertainties surrounding climate change (page 20). And, in addition to all the latest research and news from the Institute, you will read about outstanding young researchers in IIASA’s YSSP, SA-YSSP, and postdoctoral programs, whose work makes me optimistic for the future of IIASA and of the planet (page 30).

IIASA scientists are working to substantiate the debate about food & water, energy & climate change, and poverty & equity with the best possible science, as they are being discussed at the global policy agenda. A few months ago, with the European Forum Alpbach, IIASA launched a new generation of global think tank as a new partnership between leading representatives of world academia, governments, business, and civil society. It will foster fair and sustainable solutions to major global challenges such as energy, food, water, poverty, and equity, and consider their implications for economies and governance in these uncertain times.

We envisage high-level membership of the new think tank: people with proven track records and the influence to help push policies through—policies that are both timely and effective. The research to underpin the think tank deliberations will come from advanced systems analyses performed by IIASA and its global network of partners.

Our communications department has made some updates to IIASA’s running magazine, and I hope you will find this issue of Options more interesting and informative than ever before. For more updates on what is happening at the Institute, visit our Web site, or join the conversation on our new blog and our active social media channels.
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Quantifying sustainability

A new study by IIASA researchers Elena Rovenskaya, Brian Fath, 2012 YSSP participant Ali Kharrazi, and colleagues in Japan helps define a consistent way to measure the sustainability of complex systems. Sustainability is a buzzword across politics and research, but researchers have struggled to agree on a uniform definition of sustainability that can be used in interdisciplinary research.

In their recent study, published in the journal Ecological Economics, the researchers apply a new approach for measuring sustainability in any system that can be represented as an interactive flow network. This measure uses information theory to quantify the system in terms of both its efficiency and redundancy. Sustainable systems are ones that have an optimal tradeoff between these two system design features.

“As globalization increases, more economic resources are shared across borders creating a complex network of interactions,” say the researchers. That means that researchers studying limited resources must account not only for the structure of the trade network but also for the total global trade flows in which material and products are shipped around the world.

The study tests the approach for six trade flow networks of virtual water, oil, investments, and a variety of commodities, and reveals that global trade networks could be made more sustainable by improving their efficiency and reducing redundant flow pathways.

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Pitch in or drop out? Evolutionary game theory sheds light on cooperation

Two recent studies from IIASA’s Evolution and Ecology Program provide new insight into what drives human cooperation. The new studies use the framework of evolutionary game theory to examine how people act under different conditions to maximize their own best interest.

“In many groups and societies, the temptation to defect is high, which means that cheaters are much better off than cooperators,” says EEP leader Ulf Dieckmann, who conducts a variety of research in the field. Yet cooperation has evolved despite that temptation. What drives people to work together?

One study, published in the journal Nature Communications, shows that unequal wealth distribution can encourage cooperation in groups and societies in which the temptation to defect is high. For example, if a train ticket is very expensive and the probability that cheaters are caught is low, people will be tempted to free-ride without purchasing a ticket. The study shows that in situations like this, and when people interact locally, distributing a given total amount of wealth somewhat unequally, rather than fully equally, is more efficient in encouraging them to cooperate. In contrast, when the temptation to defect is low, then unequal wealth distribution has the opposite effect, instead discouraging cooperation.

“For modern societies, this study shows that unequal wealth distribution hinders our cooperative tendencies,” says IIASA’s Ádám Kun, who led the study.

A second study, led by IIASA researcher Tatsuya Sasaki, examines how institutional incentives to cooperate, such as rewards and penalties, vary in effectiveness depending on whether participation is compulsory or voluntary. In situations where participation is voluntary, institutional penalties for defection are particularly effective to encourage people to participate and cooperate, shows the study, which was published in the journal Dynamic Games and Applications.


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**Education—not fertility—key for economic development**

A recent study by IIASA researchers and colleagues at the Wittgenstein Centre for Demography and Global Human Capital, a collaborative center including IIASA, Vienna University of Economics and Business, and the Austrian Academy of Sciences, shows that improvements in education levels around the world have in fact been key drivers of economic growth in developing countries that was previously attributed to declines in fertility rates.

“Countries where a large part of the population is of working age tend to become richer quicker than those with a sizable proportion of children or elderly people,” explains Vienna University of Economics and Business professor and IIASA researcher Jesus Crespo Cuaresma, the lead author of the study.

Many demographers argue that as a consequence of declining birth rates the proportion of children in the population declines and that this results in a “demographic window of opportunity,” where a larger proportion of people is of working age.

This observation—known as the demographic dividend—was widely assumed to be a direct linkage, and had led to policy prescriptions aimed at decreasing fertility.

But, says Crespo Cuaresma, “Our study shows that such a paradigm may be flawed. Reducing fertility is not enough.”

The new study finds that instead, the previously identified association between lower birth rates and economic development is largely explained by education: as the fertility rate declines, educational levels of young adults also increased.

To tease out the causes and effects of education versus fertility rates, the researchers used a new set of educational attainment data for 105 countries around the world, reconstructed by demographers at the Wittgenstein Centre. They then used statistical models to examine the potential causative linkages between factors such as fertility rate, proportion of people in the labor force, and educational variables.

In countries where the fertility rate had declined but education levels did not increase, the economic development was not as pronounced as in countries where education levels also rose.

“The new findings demonstrate the decisive role of investments in universal education in bringing countries out of poverty,” says Wittgenstein Centre Director and IIASA World Population Program leader Wolfgang Lutz, another co-author on the study.


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**Climate change: What now?**

The IPCC released the first part of its 5th Assessment Report on climate change in September 2013. The new report ascribes even more certainty to anthropogenic climate change, and updates projections of future changes, based on scenarios produced in part at IIASA. In March and April, Working Groups II and III will release further reports focusing on adaptation and climate mitigation measures. IIASA researchers are major contributors to these reports, which go beyond the physical basis of climate change to ask, “What now?”

www.iiasa.ac.at/news/20130927-IPCC-AR5

**Accounting for emissions**

IIASA has updated its Energy and Carbon Emissions Inventory Database (ECDB), a comprehensive database on energy use, carbon emissions, and energy and carbon intensities both globally and by country for the largest carbon-emitting nations. The new update adds Egypt to the database, bringing the total number of countries to 27, which together account for roughly 80% of global carbon emissions. The update also added country-by-country data on emissions coming from land use change, an important contributor to climate change. The updated database also provides more options for users for defining GDP, as well as detailed information about uncertainties in the inventory data.

www.iiasa.ac.at/news/20130902-ECDB-update

**Renewable energy for the Alps**

IIASA has joined 15 partners in a new project—recharge.green—aimed at balancing energy needs and environmental issues in the Alps. The Alps have a great potential for renewable energy, and to make a big impact on climate mitigation. But increased renewable energy production would also increase pressure on the delicate natural environment in the Alps—a region that spans seven countries. Recharge green will analyze the costs and benefits and potential trade-offs of further renewable energy development in the region.

www.iiasa.ac.at/recharge-green

**IIASA launches blog**

The Nexus blog opens up a new discussion forum for IIASA researchers and the community.

blog.iiasa.ac.at


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Climate change means bad news for Chinese agriculture
Rising temperatures will lead to problems for agriculture in China, shows IIASA research published in the journal Climatic Change. The new research finds that expected temperature rise and precipitation changes will change the optimal growing regions for different crops, reducing yields of major crops such as wheat, corn and rice by up to 12% by 2050. It also shows that climate change will increase the need for irrigation in the country, straining already scarce water supplies. The study shows that adaptive measures, taken soon, could reduce these potential losses.

A better way to prepare for floods
Floods affect more people around the world than any other type of disaster. But while businesses are aware of the challenges posed by flood risk, most have not yet developed a holistic approach to protect themselves from these risks, according to the Zurich Insurance Group. In a new collaboration with Zurich and the Wharton Risk Management and Decision Processes Center in the USA, IIASA researchers will take a holistic approach to flood risk, aiming to the way communities prepare for and recover from floods, and to develop and disseminate knowledge and expertise on flood resilience.

Climate policies could cut mercury pollution
Policies aimed at mitigating climate change would also make a substantial dent in mercury pollution by the year 2050, shows recent IIASA research published in the journal Atmospheric Environment. The study uses IIASA’s GAINS model to examine scenarios for future emissions under different policies for climate mitigation and air pollution. It shows that policies that address air pollution alone would not be sufficient to cut mercury pollution, but that addressing climate change and air pollution simultaneously would bring greater reductions than addressing either problem alone. Mercury is a long-lasting trans-boundary pollutant that moves from the atmosphere into water and food chains, and acts as a neurotoxin at high doses.

Environmental complexity promotes biodiversity
A recent study published in the journal The American Naturalist helps explain how variation in natural environments helps spur evolution and gives rise to more biodiversity. The study suggests that a varied environment spurs the evolution of new species and promotes biodiversity by creating places of refuge——“refugia”——for new organisms to evolve.

To investigate how environmental variation affects evolution, McGill University researcher Ben Haller, in collaboration with IIASA researchers Ulf Dieckmann and Rupert Mazzucco, created a model of an environment that simulated complex spatial variation, more similar to the real world than previous theoretical models.

“We wanted to look at more realistic environments, with more random variation in environmental conditions,” says Haller. The model represents asexual organisms that reproduce somewhat like plants, and while much simpler than a real-world environment, it provides a more realistic model for study than ever before.

In addition to the new “refugium effect,” the study shows that too much variation can end up being detrimental for biodiversity. “It’s a little like the story of Goldilocks and the Three Bears,” says Haller. “For promoting biodiversity, you can have too little variation, or too much variation, or the variation can be just right.”

Also, the study shows that the scale of landscape variation, in combination with the species dispersal distance, helps determine how much biodiversity will evolve.

While many people laud the idea of preserving biodiversity, says Haller, much remains unknown about what an environment needs in order to maintain or produce biodiversity. He adds: “It’s very hard to conserve something that you don’t even understand.”

Haller started the work as part of his participation in IIASA’s Young Scientists Summer Program, working with Dieckmann and Mazzucco. Read an interview with Ben Haller on IIASA’s research blog Nexus: blog.iiasa.ac.at.


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Study puts numbers on universal energy access

Universal access to modern energy could be achieved with an investment of between $65 and 86 billion a year up until 2030, according to a recent study published in the journal Environmental Research Letters. The study provides a policy blueprint that could help achieve universal energy access, one of three key objectives in the United Nations “Sustainable Energy for All” initiative, and for the first time quantifies the policy costs of such an effort.

But without dedicated efforts, these goals will become hard to reach, says IIASA researcher Shonali Pachauri, who led the study. She says, “Our analysis indicates that without new policies and efforts, universal access to modern energy will not be achieved by 2030. Actually, for cooking, the situation may even worsen.”

The proposed investments are higher than previous estimates, but equate to just 3 to 4% of current investments in the global energy system. Recent estimates from the Global Burden of Disease Study 2010 state that the lack of access to clean cooking options is responsible for the early death of four million people annually, mostly women and children. The authors of this study calculate that improved access to modern cooking fuels could avert between 0.6 and 1.8 million premature deaths in 2030 and enhance well-being substantially.

The researchers estimate that the additional generation capacity needed to provide a modest amount of electricity to all rural households would cost around $180 to 250 billion over the next 20 years. Dedicated policies and measures would also be needed to achieve this.

Easing the transition to clean cooking for more than 40% of the world’s population would cost an additional $750 to 1000 billion over the next 20 years, the researchers say. The policies would include subsidies supporting the costs of new fuels, new stoves, and improved biomass stoves.

“The scale of investment required is small from a global perspective, though it will require additional financing for nations that are least likely to have access to sources of finances,” says Pachauri. “But the benefits could be enormous.”

Citizen scientists rival experts in analyzing land-cover data

Over the past 5 years, IIASA researchers on the Geo-Wiki project have been leading a team of citizen scientists who examine satellite data to categorize land cover or identify places where people live and farm. These data have led to several publications published in peer-reviewed journals.

“One question we always get is whether the analysis from laypeople is as good as that from experts. Can we rely on non-experts to provide accurate data analysis?” says IIASA researcher Linda See, who led a new study to answer that question, recently published in the journal PLOS ONE.

The researchers compared 53,000 data points analyzed by more than 60 individuals, including experts and non-experts in remote sensing and geospatial sciences. The new study shows that non-experts are as good as experts at identifying human impact, a concept that has emerged from ecological sciences, in satellite land cover data.

However, the study showed, experts were better at identifying the specific land-cover types such as forest, farmland, grassland, or desert. When presented with control data where researchers knew the land-cover type, experts identified land cover correctly 69% of the time, while non-experts made correct classifications only 62% of the time. The researchers suggest that interactive training and feedback could help non-experts learn to make better classifications and continue to improve these numbers in the future.

“Citizen science has actually been around for a very long time in many different guises,” says See. “But as the Internet continues to proliferate in the developing world, and mobile devices and wearable sensors become the norm, we will see an explosion of activity in this area.”

Further information


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Solutions for nitrogen pollution

Nitrogen is essential for life on our planet. But using too much of this element leads to air pollution, contaminates drinking water, damages ecosystems, and contributes to global warming—and the problem is getting worse. IIASA researchers Wilfried Winiwarter and Zbigniew Klimont recently contributed to a recent United Nations Environment Report (UNEP), which provided a clear list of potential solutions for improving the efficiency of fertilizer use in agriculture, saving money for farmers and reducing pollution. The report was co-organized by the International Nitrogen Initiative (INI), for which Winiwarter heads the European regional center.

IIASA scientists contribute to climate reports

IIASA scientists are among 300 experts worldwide contributing to the Fifth Assessment Report of the IPCC (IPCC AR5). The release of AR5, which began in September 2013, will culminate in the publication of the final Working Group in April 2014. Against a background of international failure to reach a climate strategy dating back to the 2009 Copenhagen summit, AR5 is expected, like its predecessor, to prompt more national-level efforts toward energy system transition away from fossil fuel and high emission pathways. Collectively, such national efforts could deliver the technological progress needed to make a global transition possible.

Vienna Energy Forum

In May 2013, IIASA co-organized the third Vienna Energy Forum (VEF) with UNIDO and the Austrian Federal Ministry for European and International Affairs. The VEF gave the 1500 energy experts and policymakers who attended an opportunity to talk face to face about key sustainable energy issues, including policies, markets, finance and technologies. One aim of the 2013 Forum was to enhance understanding of sustainable energy’s fit into the broader post-2015 development framework under the SE4ALL initiative, to which IIASA Deputy Director Nebojsa Nakicenovic is a high-level technical advisor. Kandeh Yumkella, pictured above at the VEF opening ceremony, now heads the SE4All Initiative.

“Beyond 2014”

The June 2013 Regional Report of the UN Economic Council for Europe (UNECE) drew abundantly on the analytical work and projections of the IIASA World Population Program analysis, “Population Trends and Policy Responses in the UNECE Region: Outcomes, Policies and Possibilities.” The IIASA analysis was commissioned by the UN Population Fund as part of a review of the implementation of the Programme of Action (PoA) of the 1994 International Conference on Population and Development (ICPD), which redefined population issues primarily from the perspective of people’s empowerment and human rights-based development. The IIASA research contribution was noted in “ICPD Beyond 2014: The UNECE Region’s Perspective,” which gives an overview of achievements and challenges experienced by UNECE Member States 20 years after the adoption of the PoA.
Green light for green energy

Roadmap for negative emissions future planned for Indonesia, based on research using IIASA’s BeWhere and G4M models

IAASA, together with the International Energy Agency, is working with Indonesian government, scientific, and business stakeholders to facilitate a shift toward bioenergy with carbon capture and storage (BECCS) in the country.

A recent workshop on the topic, organized by IIASA’s NMO in the country, UKP4, and the Indonesian Ministry of Energy and Mineral Resources (MEMR), took place in Jakarta in August 2013. It looked at developing a strategic roadmap on appropriate aspects of future viable bioenergy and CCS policies in the archipelago.

Indonesia, which joined IIASA in 2011, faces huge energy challenges if it is to meet the government’s “pro-poor, pro-jobs, pro-growth, and pro-environment” development vision, while making good its vow to reduce national emissions by 26% below the business-as-usual level by 2020, with a further reduction of up to 41% if adequate international support is provided.

Indonesia is the third-highest emitter of greenhouse gases (GHGs) in the world, after the USA and China, with most emissions coming from land uses and land-use changes, particularly deforestation. BECCS could be the answer to the tropical country’s energy problems, not only lowering the current account deficit caused by fuel import, but enhancing domestic energy security and alleviating poverty especially in rural areas. There are still, however, numerous obstacles to bioenergy, CCS, and BECCS development. These include: (i) raising public awareness, education, and capacity building to create an enabling environment for utilizing Indonesia’s substantial potential; (ii) better planning, coordination, and synergy among different entities, especially given the scattered availability of energy resources such as forest biomass as well as urban and agricultural waste; (iii) the sustainability questions hanging over the use of, for example, forest biomass or plantations such as oil palm.

At the workshop, IIASA researcher Florian Kraxner showed how studies based on IIASA’s BeWhere and G4M models could help select BECCS options based on optimal location, sustainable feedstock use, and ease of implementation. For Indonesia, as in other countries like Korea, Japan, or Russia previously analyzed by IIASA, the successful co-firing of biomass in coal power plants was dependent on issues like the possible location and the yield of biomass, location, and population of cities being served, biomass plant parameters, and economic factors. Experimental results showed that BECCS could be profitable in Indonesia, as long as sustainable practices are introduced that suit domestic resource potential and energy needs, and if current government energy subsidies on fossil fuels are removed. Thus, as well as improving public awareness about dwindling fossil fuel availability and costs, firm incentives and feed-in tariffs would be needed to stimulate further bioenergy and BECCS development.

The negative emissions potential of BECCS in Indonesia is clearly advantageous. Workshop participants therefore decided to conduct comprehensive case studies to test bio-energy, CCS, and BECCS that link the development of bioenergy with possible CCS sinks. They also determined that a network of expertise from government, science, and policy should be formed on bio-energy to bridge domestic and international capacity, with Indonesia’s Ministry of Energy and Mineral Resources at the hub. Several institutions present at the workshop showed a great deal of interest in BECCS and IIASA research, and a possible follow-up workshop might take place in Norway, which provides substantive funds for Indonesian forests. Insights from ongoing bioenergy studies will also feed into IIASA’s Tropical Flagship Initiative, to be launched in early 2014 in Indonesia (see page 18).
Energy research has been a pillar of IIASA ever since the Institute’s inception in 1972. IIASA’s first major flagship program was a truly global and long-term study of future energy systems which culminated in the publication of *Energy in a Finite World* in 1981. This study established the need to make a critical transition from a fossil-based global energy system through model-based scenarios and provided the first-ever assessment of the major energy challenges. Over the last three decades, energy research at IIASA has become even more integrated and comprehensive, dealing with all the major global challenges.

IIASA’s energy research continued with major publications such as the *Global Energy Perspectives*, published in 1998 jointly with the World Energy Council. Indeed, IIASA has made enormous ongoing contributions to the work of the assessment reports of the Intergovernmental Panel on Climate Change (IPCC) and related publications.

In 2011 our energy research was given a new focus in line with IIASA’s latest strategic plan. This expansive research culminated in many publications including the *Global Energy Assessment* (GEA), coordinated by IIASA and involving 500 leading scientists, energy experts, and policymakers from around the globe. GEA research has informed, among other efforts, the United Nations Sustainable Energy for All (SE4ALL) initiative, which aims to make access to affordable energy services for all a reality by 2030. The SE4All objectives are rooted in GEA pathways and include providing universal access to modern energy, doubling the share of renewable energy globally, and doubling the rate of improvement in energy efficiency—all by 2030. In addition GEA pathways aim to achieve the stabilization of global average temperature change to 2°C above pre-industrial levels, and to improve energy security. GEA analysis indicates that achieving these goals would require new dedicated and sustained policies and a rapid transformation to clean energy technologies, translating into an increase in annual investments from present levels of approximately $1.3 trillion to $1.7–2.2 trillion, about 2% of current world GDP. The difference corresponds roughly to the energy subsidies that currently go mainly to fossil fuel sources, often impeding the needed transformational change.

The goals set by the SE4All objectives are very aspirational but also very achievable. Two important activities, both outcomes of the Rio+20 meeting in 2012, aim to help realize some of these goals. The Sustainable Development Solutions Network (SDSN) and the Green Bridge initiative, which IIASA is involved in, aim to achieve full decarbonization of the global energy system and reach the 2°C target, consistent with the GEA objectives.

IIASA remains a central hub for global energy research, supporting the discussions at global forums such as the Vienna Energy Forum, which IIASA co-hosted, and most recently, the 2013 World Energy Congress in Daegu, Korea. Our integrated analyses provide the necessary information for the international policy action needed to transform the world’s energy system. A major finding of the more recent energy research at IIASA is that some energy options provide multiple benefits. By addressing both energy access and air pollution mitigation together, the costs of achieving each separately could be halved, demonstrating the power of integrated assessments.
A passion for science

IIASA’s Elena Rovenskaya explains how IIASA researchers develop the models they use to understand complex systems

Q Dr. Elena Rovenskaya, what’s a mathematical model?
A A simplification of reality, elegantly expressed through equations.

Q An oversimplification, perhaps?
A No, what we model is usually dictated by researchers’ interests or project requirements. We capture as much detail as needed. With today’s computing power, that can be a lot.

Q So you write equations…
A Yes, sometimes one; sometimes 10,000.

Q What could one equation show?
A It could capture a conceptual process of economic development comprising different levels of authorities, thousands of companies, and millions of people—all within a standard framework of economic growth theory.

Q Give a recent example of how IIASA created a new model.
A We worked with a team from Finland’s Ministry of Economy, a country with an IIASA NMO. This comprised the Minister’s Advisor and representatives of three Finnish regions. We asked about the regions’ current and past economic situations, the government’s goals, and what policies they had in mind for achieving them. As always in an open and friendly meeting, our ideas became gradually “interconnected,” which made writing a good model easier.

Q Do you extrapolate past trends to project the future?
A Sometimes, but the future is going to see big structural changes in all global sectors. So we can’t use the past in a mechanical way. Old data are useful for “soft” validation purposes. We can fit our model to data from, say, 1950–1970 to project outcomes for 1970–1990, and knowing what happened in the 70s and 80s, we can check our model is on track.

Q IIASA is building some big integrated models like GLOBIOM, which assesses the competition for land use between agriculture, bioenergy, forestry, and livestock. These have several modules—submodels. How do researchers “bolt” submodels together?
A Technically the models are tied together by a special code. Conceptually, you need to turn outputs from one submodel into inputs to another. This may change the performance of each submodel; so again it’s not mechanistic, it requires brainpower!

Q Your modeling results don’t always agree with those of other institutions.
A Each model looks at reality from its own angle. So it’s natural for results not to coincide.

Q What does integrated modeling show you?
A It gives a tremendous overview of the problems, as well as profound insights into the co-benefits and trade-offs needed to achieve the required goals.

Q What’s good about modeling at IIASA?
A The freedom to explore and experiment. There aren’t the constraints you’d find in academia. Maybe not all our studies are successful, but there’s a chance to make enormous breakthroughs.

Q And finally, why do Russians have a reputation for being so good at math?
A Our teachers in Russia came from a generation with a passion for science. It was reflected everywhere, for example in science fiction. Scientists, especially physicists and mathematicians, were heroes in life and in art, and to us they had the most interesting lives. This was a very strong—and romantic—motivation to become a good scientist.
In September of 2012, the thick blanket of ice that covers most of the Arctic Ocean had retreated to just a little over half its average minimum extent, hitting a new record low. Meanwhile Arctic temperatures have risen on average 4°C over the last 100 years, almost twice as much as at lower latitudes. Scientists say that the warming of the Arctic is primarily caused by climate change from carbon dioxide, which remains in the atmosphere for decades to centuries. However, shorter-lived greenhouse gases and air pollutants including methane and black carbon also contribute to the warming—making them attractive targets for mitigation efforts that have immediate impact and can complement reductions in CO₂ emissions.

“We might not be able to stop the warming of the Arctic. But there are things we can do to make a difference in how much it warms and how soon,” says IIASA researcher Zbigniew Klimont. Over the last several years, Klimont and colleague Kaarle Kupiainen have collaborated with Arctic policy and science efforts such as the Arctic Council and the Arctic Monitoring and Assessment Program (AMAP) to look at how warming could be reduced in the region. Their latest project, called “Mitigation of Arctic warming by controlling European black carbon emissions” (MACEB), recently completed, homed in on one Arctic country: Finland. It combined emissions modeling with experimental work and a practical on-the-ground outreach component, to provide a better understanding of what can be done to limit future warming.

From global research to local action

Previous research by IIASA and other groups had already shown that cutting black carbon—soot—could quickly and cheaply make an impact on climate warming. While the dark-colored particles have a strong warming effect, absorbing heat both in the atmosphere and on the surface of snow and ice, the pollutant doesn’t last long in the atmosphere.

But those studies made only broad, global predictions. “In a lot of these large scale and global climate models, the resolution is too coarse to answer these regional questions,” says Klimont, one of the MACEB study leaders. “The question is: Can we do something with mitigating black carbon to reduce the impact of warming in the Arctic?”

To answer that question the research team, which included IIASA, the Finnish Meteorological Institute, the University of Helsinki, and the Finnish Environmental Institute, decided to take on the biggest source of black carbon in the country—the
Clearing the Arctic air

Wood burning stoves that many Finnish people use to heat their homes and saunas. “We used Finland as a sort of case study area,” explains Kupiainen. Interviews with chimney sweeps had confirmed that many Finnish stove owners make mistakes in their operation that lead to more pollution. “If you make the normal so-called user errors, your stove can release as much as triple the black carbon emissions” says Kupiainen.

So the project also included a public relations campaign to teach people how to better operate their stoves. Klimont says, “This was a practical attempt on the ground. The chimney sweeps essentially went out as missionaries, with pamphlets to teach better stove operation.” The researchers expect to evaluate the impacts of this effort as part of future projects.

The study also included experiments to measure how much black carbon contributes to snow melt. University of Helsinki researchers designed a soot blowing machine that could disperse soot over areas of snow, where they then measured the change in albedo (reflectivity) and snowmelt under varying conditions. They also took measurements at five locations around Finland—data that were used to validate the emissions models.

The MACEB project combined theoretical modeling with experimental work. Here, researchers measure how black carbon influences snow reflectivity and melt.

The future of the ice

How much can this Finland-focused study say about the future of the Arctic as a whole? Other Arctic countries such as Canada, Russia, and the United States emit larger amounts of black carbon, some of that from oil and gas extraction operations, an activity which is not present in Finland. Nevertheless, the study’s methods and findings could be extended to different regions and different emission sources. Klimont says, “The contribution of Finland to emissions in the Arctic area is not very large—a few percent at most. But our experience can be transferred to other countries.”

The researchers have found an avid audience for their findings among policymakers in Europe—where the next round of air pollution guidelines are currently being negotiated—as well as in circumpolar countries, which stand to be most strongly affected by Arctic warming. Kupiainen says, “Arctic communities are eager to get more data on impacts.”

Further information: www.iiasa.ac.at/MACEB • http://maceb.fi

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The food we eat has impacts on land, water, forests, and the world’s climate. IIASA research shows the way toward a more sustainable future.

TOOLS OF THE TRADE

How do IIASA researchers dig in to the details of food production and consumption? Two models explore different aspects of the topic:

IIASA’S GLOBIOM MODEL examines the agricultural and forestry sectors with a great detail on the production side including spatially explicit parameterization of crop and livestock productions systems, and forest management. This model allows users to assess the impacts of future demand for food, feed, fiber and fuels on land and water use and climate. It also gives policymakers a way to assess the benefits and tradeoffs of different production choices, on a global as well as regional level. [www.iiasa.ac.at/globiom](http://www.iiasa.ac.at/globiom)

IIASA’S LANDFLOW MODEL is an accounting model that ties consumption to its impact on resource use, by tracking agricultural and forestry land area extents of the whole supply chain from primary production, via trade, to utilization for food, feed or other uses. The model allows researchers to trace the production and movement of commodities and their embodied natural resources through global trade networks. [www.iiasa.ac.at/landflow](http://www.iiasa.ac.at/landflow)
When you shop at the small grocery store in the town of Laxenburg, Austria, chances are that your fellow shoppers—researchers who work across the street at the International Institute for Applied Systems Analysis (IIASA)—see more than just lunch in the food they put in their baskets.

In food products such as beef, pork, or poultry, for instance, IIASA researcher Sylvia Tramberend sees deforestation in South America, caused by land clearances to produce the oil crops that feed European livestock. She spends her days analyzing the deforestation, land use changes, and water that go toward producing food and goods for human consumption. “How much land did it take to produce that hamburger, where is it located, and what are the impacts of using natural resources like land or water for food production?” she wonders.

Another IIASA scientist, Hugo Valin, studies the climate impact of crop and livestock production around the world. He knows in great detail how production of the different foods he eats contributes to climate change.

And Evolution and Ecology Program Leader Ulf Dieckmann, who models fisheries and fisheries policy, knows whether the different brands of smoked salmon in the store’s refrigerator section are caught sustainably, factory farmed, or harvested from a fishery on the verge of collapse.

As one of IIASA’s core research areas, food is on the mind of many scientists at the Institute, tying into research on land use, climate, energy, water, natural ecosystems, and poverty. Researchers project that we will need a 60% increase in cropland output and a 70% increase in meat and dairy production in order to meet the growing food demand by 2050. In the past 50 years, production has increased substantially because of improvements in efficiency coming from irrigation and fertilization. Where will future increases come from? And what environmental impacts will they have on our planet?
FOOD AND LAND

In a recent study commissioned by the European Commission, Sylvia Tramberend and colleagues Günther Fischer, Eva Hizsnyik, and Harrij Van Velthuizen examined how consumption in Europe affects forests around the globe. The study showed that goods consumed in the EU contributed to approximately 90,000 square kilometers of lost forestland from 1990 to 2008.

Europe’s biggest impact on deforestation comes from meat consumption, the study showed. Whether meat is produced in Europe or abroad, it is often fed on oil crops such as soybeans that are grown in South America and contribute to deforestation there. The new report provides policy recommendations to help Europe reduce its impact on the global environment such as promoting relevant concepts and measures to increase agricultural production without increasing climate impact—“climate smart agriculture,” raising awareness of the linkage between EU food consumption and deforestation, strengthening the environmental provisions in trade agreements, or assisting in the development of a responsible investment framework.

The new study relied on a mathematical model called LANDFLOW which IIASA researchers have developed to track where land-based goods are produced and how consumption impacts land use around the world.

“Because of globalization, the supply chain is getting more and more complicated,” Tramberend says. “In order to understand this global network, we have to look at agricultural production across the whole planet. LANDFLOW captures all commodity flows by using the large, harmonized time series databases on land use, production, trade and commodity utilization of the Food and Agricultural Organization (FAO).”

The researchers are now expanding LANDFLOW to examine not just land use and deforestation, but also how agricultural consumption impacts nutrient cycles and water resources—a major question for the future, as researchers predict that climate change, population growth and increasing competition with water demand from industry and the domestic sector will further stress already scarce water resources.

FOOD AND CLIMATE

Researchers like Hugo Valin in IIASA’s Ecosystems Services and Management program look at food impacts from another perspective—particularly, how food production impacts the climate, and how food production can be increased without adding to these impacts. Agriculture contributes about one-third of total anthropogenic greenhouse gas emissions, with the largest share of those emissions coming from livestock production.

« We know that livestock have a big impact on climate and the environment.

But all livestock is not the same. »

—Petr Havlík

Valin recently published work in the journal Environmental Research Letters showing that, by using sustainable methods, it would be possible to improve crop yields while emitting
12% less per calorie produced than with conventional intensive farming. Valin says, “The most efficient way to ensure sustainable intensification on the crop side is to rely on practices and technologies that do not require more fertilizer, such as new varieties, improved rotations, integrated crop-livestock practices, and precision farming.”

The study, which relied on IIASA’s GLOBIO model, also showed that the greatest benefits in greenhouse gas reduction could come from strategies that improve the efficiency of livestock production.

The GLOBIO team, in collaboration with the International Livestock Research Institute (ILRI), recently completed a new database that quantifies the climate impacts of livestock production on a global scale. Project leader Petr Havlík explains, “We know that livestock have a big impact on climate and the environment. But all livestock is not the same. Our new database compiles quantitative characteristics of livestock production systems across the world which allows us to discriminate between the good, the bad, and the ugly, and by this offers opportunities for future livestock production developments with limited negative environmental impacts. This information will allow decision makers to better design environmental and livestock policies which reconcile climate change mitigation and food security.”

**FOOD AND THE OCEANS**

At the IIASA conference last October, Ulf Dieckmann noted that seafood provides the primary source of animal protein for over 1 billion people. But several fisheries around the world are in danger of collapse, and the policy changes needed to make them sustainable are difficult to determine and implement. Dieckmann and colleagues’ ongoing research examines how to manage fisheries sustainably so that they can continue to produce food for future generations.

“**There is a big difference between preventing stocks from collapsing and managing them to achieve an optimal harvest.**”

—Ulf Dieckmann

In a recent study in the journal *Proceedings of the National Academy of Sciences*, Dieckmann and colleagues provided a new model for determining harvesting rules that could not only preserve the stock of Northeast Arctic cod, but would actually increase harvests from this stock in the long term—although this would require a short-term reduction in harvests. Northeast Arctic cod is one of the most commercially important fisheries in the world. The study, led by former YSSP participant Anna Maria Eikeset, showed that optimal harvesting based on the new model would moreover promote beneficial evolutionary changes that lead to enhanced reproduction among fish in the stock. Dieckmann says, “There is a big difference between preventing stocks from collapsing and managing them to achieve an optimal harvest.”

**FROM RESEARCH TO APPLICATION**

While foraging for their lunch in the aisles of the local grocery store, Tramberend, Valin, and other IIASA food researchers do not always find it easy to make informed decisions about the goods they consume. “It’s difficult to be a conscientious consumer even if you want to,” says Tramberend. “Because of the complexity of the supply chain, it can be difficult to find out how and where the food you eat was produced.” And even if you know, accounting for all impacts along the food chain and comparing alternative products can be difficult. For example, a tomato grown in a heated greenhouse in Europe may take more energy to grow and reach consumers than a tomato grown somewhere warmer and shipped from abroad. But even if it seems difficult, Tramberend says that consumer efforts to make sustainable choices do matter. “When consumers reach for ‘green’ products, the food industry and agricultural producers will respond,” she says.

The recent studies described in this article are just a few examples of the work that IIASA scientists do to connect food production and consumption to the impacts it has on the environment. At the same time, IIASA researchers are examining how to make sure that enough food will be available for future generations and to share equitably around the world, and to examine how changes in connected systems such as climate and energy will impact food production.

Like most IIASA research, the studies mentioned in these pages feed directly into policy—the results have been described in reports and recommendations for Europe as a whole, as well as countries around the world, providing a roadmap for policymakers looking for answers about how to feed growing populations, how to slow climate change, and how to protect precious water resources.

**REDUCING YOUR FOOD FOOTPRINT**

What can you do to reduce the impact that your food choices make on the environment? It’s a complex question, say IIASA researchers, but there are some steps you can take.

Many people say that the easiest way to cut your environmental footprint is to reduce meat consumption. Meat takes more land, energy, and water to produce compared to a vegetarian diet and leads to greater greenhouse gas emissions. However, all meat is not equal. Valin says, “The impact depends a lot on what type of meat, and where and how it was produced.”

Another strategy is to eat foods that you can trace to their source. Sylvia Tramberend notes that while people often think of local or regionally produced food as more sustainable, it is not always less costly for the environment. Instead, she says, try to find out more about where and how your food is produced. For example, choosing coffee or cocoa from sources that commit to preventing deforestation can help protect forests and provide important stimulus for more sustainable production practices. Likewise, choosing to eat fish from sustainable marine fisheries helps support those fisheries.

The simplest and most certain way to reduce your impact requires little thought. Consume less, whether by eating less or reducing the amount of food you waste. Havlík says, “The only thing we can say with certainty is common sense—there is a lot of overconsumption and waste.”

**further information**


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With its National Member Organizations in Brazil and Indonesia, IIASA will launch a multi-year flagship project for the Tropics

With its National Member Organizations of Brazil and Indonesia, IIASA is launching a multi-year flagship project for the Tropics. Malaysia and Vietnam may come on board, as funds permit. Furthermore, Australia, Japan, the USA, and some European countries, already active in the area of avoiding deforestation, have indicated interest in very specific and case study-related cooperation under IIASA’s initiative. The initial project emphasis on reducing tropical deforestation will expand to cover GHG emissions, air pollution, agriculture, water, and related industries and markets. Although the Tropics cover only 6% of land surface, our earthly “waistband” harbors most of global biodiversity—from the world’s tallest known tree to the tiny organisms that contribute in ways still unknown to the web of life.

Felling tropical rainforests for animal pasture, palm oil plantations, or pulp and paper businesses, is reducing biodiversity that has evolved over thousands of years. Moreover, the peatlands that cradle many tropical swamp forests have accumulated huge soil carbon that, when disturbed, particularly through large-scale drainage and slash-and-burn land clearances, switch from being a carbon sink to a carbon source. According to WWF, deforestation worldwide is responsible for around 15% of all greenhouse gases (GHGs), equal to the global transport sector. Over half of this (51%) is generated by Brazil and Indonesia, home to the biggest rainforests in South America and southeast Asia, respectively.

To stop deforestation and for long-term social and economic prosperity, it is crucial that tropical countries move toward sustainable forest management through a UN process known as Reducing Deforestation and Forest Degradation (REDD). The REDD process, recognized at COP13 in Bali, added a “+” factor in 2010 to signify the addition of forest sustainability criteria to the original aims.

IIASA’s new Tropical Flagship Project will begin with a focus on tropical deforestation and will expand to cover emissions, air pollution, agriculture, and water. The first step is a quantitative global, regional, and national REDD+ assessment for Brazil and Indonesia. Researchers will assess policy options, mitigation potentials, investment costs in forestry and agriculture, linkages to the different carbon markets, and synergies as well as trade-offs with other environmental policies and the bio-economy in general. IIASA models such as the global economic land use model (GLOBIOM) and the global biophysical forestry model (G4M) will be used to support high-resolution policy planning for avoiding deforestation, as well as promoting REDD+ and biodiversity protection.

Some 75 countries are now ready to implement a national REDD architecture based on (i) the generation of measurable, reportable and verifiable (MRV) REDD+ credits, and (ii) the sustainable and efficient provision of emission reductions under a robust financing regime. The next step in this informal process will be a close link between the Tropical Flagship Project and IIASA’s REDD+ Policy Assessment Centre (REDD-PAC), a project launched in 2011 that is funded by the German International Climate Initiative (IKI). This will help to solidify gains already made, add more technical know-how, and provide a global forum for sharing and improving data.

Brazil and Indonesia have been involved in avoiding deforestation and in REDD activities at the subnational level. Through REDD efforts to date, Brazil has been able to establish more than 200,000 square kilometers of protected areas in the Amazon rainforest, bringing deforestation down “by a whopping 78% from its
recent high in 2004," according to Nature (486:5). "If Brazil can maintain that progress," the journal continues, "it would be the biggest environmental success story in decades, and would set an example to other countries that want to protect their tropical forests." Indonesia is also in the process of substantially slashing deforestation rates. Through IIASA’s new project, the successes of Brazil can be transferred to Indonesia. The latter can then put itself on the world map of climate mitigation giants, while developing a new export industry of ecosystem services.

“This project is uniquely positioned to generate key elements of transformational change,” says Dr. Michael Obersteiner, Leader of IIASA’s Ecosystems Services and Management (ESM) Program, which will head up the new project, including liaison with in-country organizations and international partners. “A key enabling mechanism will be a research school to build in-situ quantitative assessment capacity and provide active technology transfer among project partners.”

A second step will be to refine research to the province level. The Indonesian provinces of Central Kalimantan, East Kalimantan, and Jambi in south-central Sumatra are early front runners for inclusion in the project. Here, natural forests have been felled to make way for development in the form of new jobs, residential areas, and industrial and agricultural initiatives, with associated emissions of carbon dioxide and the loss of forest carbon sinks and biodiversity. Research is already under way to find a sustainable way of producing palm oil, a mainstay of tropical economies given its worldwide use—some 50% of supermarket products, from food to soaps, contain palm oil.

The younger generation of Indonesia worry about their tropical future. Ade, Desy, and Yulina—eighth graders at a Central Kalimantan school, Bina Cita Utama—write in their environmental blog:

“The world would die without trees, just like a person would die without lungs.”

—Ade, Desy, and Yulina, eighth graders at the Bina Cita Utama School, Central Kalimantan, Indonesia

Further Information IIASA’s REDD-PAC project: www.iiasa.ac.at/REDD-PAC

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It is crucial to understand how climate change can affect the current and future functioning of human societies and economies and how we can adapt—as a whole and in parts.”

—Pavel Kabat

Although climate change impacts have been modeled in one-off assessments, impacts frequently extend beyond the climate system itself, affecting both environmental and socioeconomic systems.

One way to pull together information across such a broad field is to compare the results from different models that address a specific question. Scientists have already performed model intercomparisons for the physics of the climate system, the economy of climate protection, and climate impacts on specific sectors.

The new Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP) is the first to produce state-of-the-art climate impact studies with the focus on climate change effects on human beings. ISI-MIP is a collaboration between IIASA and the Potsdam Institute for Climate Impact Research (PIK), with backing from Working Groups II and III of the Intergovernmental Panel on Climate Change (IPCC). It relies on the research framework of the Representative Concentration Pathways Options and the Shared Socioeconomic Pathways (see Options, summer 2012), which IIASA played a large role in developing, and its organization is based on the Water Model Intercomparison Project (WaterMIP), in which IIASA Director and Chief Executive Officer Professor Dr. Kabat is involved. According to PIK Director, John Schnellnhuber, this comprehensive and rigorous model inter-comparison will “help to fill a sore gap in the IPCC’s report,” and in future research.

One of the systems examined by ISI-MIP research is water. It is known that as the planet warms, a growing number of people globally will be affected by severe reductions in water resources. Others will also experience increases in average water availability, due to higher or more frequent precipitation.

What we don’t know with any degree of certainty is: How much warmer will the climate become? How many more people will be affected? How severely will water resources be reduced? How much more water will be available? How great will the adverse effects be? And where, geographically, will water deficits or surpluses occur?

A series of papers on every aspect of climate impacts was recently published in a special issue of the journal Proceedings of the National Academy of Sciences (PNAS), co-edited by Schellnhuber, Kabat, and Frieler. More details about some of the studies in that issue can be found on the following page. KP

Further information
A 2013 PNAS Special Issue on the ISI-MIP Project—edited by John Schellnhuber, Pavel Kabat, and Katja Frieler—includes the following articles:

- Piontek F, Müller C, Pugh TAM, et al. Multisectoral climate impacts in a warming world
- Nelson GC, Valin H, Sands RD, et al. Climate change effects on agriculture: Economic responses to biophysical shocks
Climate impact hotspots across sectors

Ten percent of people are likely to live in a climate impact hotspot by century’s end, if greenhouse gas emissions continue unabated, according to a second ISI-MIP study also featured in the PNAS special issue on climate impacts. Many more are put at risk in a worst-case scenario of the combined impacts on crop yields, water availability, ecosystems, and health. The Amazon, Mediterranean, and East Africa are regions that might experience severe change in multiple sectors. Pictured below, a deserted drought-struck village in Mauritania, a potential hotspot of climate impacts.

Climate effects on agriculture

A third important project featured in the PNAS special issue examines how climate change will affect agricultural production, and thus food cost and availability. Past studies of climate change effects on agriculture produced substantially different results because of model, scenario, and data differences.

IIASA researchers working on AgMIP, an ISI-MIP sub-project, compared potential scenarios for future agricultural production using a variety of climate, crop, and economic models and identified gaps and inconsistencies. AgMIP aims improve substantially the characterization of world food security due to climate change and to enhance agricultural adaptation capacity in both developing and developed countries.

The project will also feature in a special issue of the journal Agricultural Economics.
Coping strategies of disaster-struck households in Uganda

After natural disasters hit—floods, earthquakes, or drought—impacted households have to take measures to cope, such as reducing their consumption of food and water, or selling assets such as cattle.

What choices will households make in such situations? Will the choices harm their chances of generating income in the future? And who is most vulnerable?

To find out, IIASA scientist Stefan Hochrainer-Stigler and collaborators conducted one of the largest surveys of its kind in rural Uganda, posing a hypothetical disaster to workers that would render them unable to rely on outside help. The team used smartphone technology to gather more than 3000 observations, and they found the workers’ most frequently reported choice of coping strategy would be to sell livestock.

This striking result runs counter to the findings of previous studies indicating that sale of livestock plays only a minor role in coping with weather extremes, says Hochrainer-Stigler. “Our analysis supports the argument that livestock is held as a form of liquid savings, and one possible use of it is to recover from a shock.”

The findings also revealed that the households did not choose coping strategies based on what other people around them chose, but on a number of different factors. One important factor in the choice of coping strategy was initial vulnerability, such as lack of income diversification.

Deforestation and greenhouse gas emissions in the Congo Basin

While deforestation rates in the Congo Basin have been low compared to those in the Amazon, they could increase to between 0.4 and 1.3 million hectares per year from 2020 to 2030, according to IIASA research. Moreover, the removal of trees would elevate carbon dioxide emissions from the region and contribute from 5 to 20% of global carbon dioxide emissions in that timespan.

To determine the possible deforestation rates in six Congo Basin countries, IIASA researcher Aline Mosnier and colleagues used IIASA’s GLOBIOM model to look at how the increase in population—which will double by 2030 compared to 2000 in the Congo Basin—and the improvement of transportation infrastructure will impact separate demands for land use from agriculture, forestry, and energy. Increased demand from the rest of the world including higher demand for biofuels and for meat was also tested. The team used the model to generate potential greenhouse gas (GHG) emissions from deforestation in the Basin countries between 2010 and 2030.

In addition, the researchers analyzed the impact of the implementation of an international agreement on reduction of global emissions from deforestation. Since alternative use of forests is not as profitable here as in other tropical forest basins, important cuts in deforestation rates and emissions this could be achieved from the region. However, without complementary measures or increased food production, these cuts would require significant increases in the local price of food and in the degree of food imports.

While considering policies for reducing deforestation and forest degradation (known as REDD+), decision makers should analyze the overall development strategy of the entire region to determine an outcome that is both beneficial for the international community and the Congo Basin countries, the researchers say. REDD+ policy options and biodiversity protection in the Congo Basin are currently being further investigated with IIASA’s REDD-PAC project.


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Climate change outlook for Bolivia

Rapid glacier retreat in the Andes is impacting drinking water supplies, agriculture, and power generation in Bolivia—a country where one-third of the labor force works in agriculture. Other climate changes, such as increasing numbers of droughts and floods, also threaten the economy.

“Bolivia is considered to be extremely vulnerable to climate change,” says Christian Seiler, first author of a study investigating the likely ranges of climate change in Bolivia.

The researchers—IASA Director and Chief Executive Officer Professor Dr. Pavel Kabat, Seiler, working as Kabat’s graduate student, and one collaborator—intend to improve upon existing climate models, which do not yet simulate climate changes at the high spatial resolution necessary to infer a meaningful assessment of impacts in a geographically diverse country like Bolivia.

Given the large uncertainty between the projections of current models, however, the researchers’ first step was to evaluate 35 different climate models to see how accurately they were able to reproduce past conditions in the country. The team then used these models to analyze projected changes in Bolivia’s climate under five distinct scenarios (different levels of increasing greenhouse gas emissions) for 2070–2099.

The team found the models consistently projected significant increases in temperature, the range of increase varying from 2.5 to 5.9 °C, and nearly one-fifth less rainfall in the five drier months of the year.

“We hope that our findings may provide inputs to further assess how resilient human and natural systems are under different climate change scenarios,” Seiler says.


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District Heating potential in the USA

District Heating (DH)—a system for distributing heat generated in a central location to meet residential and commercial heating needs—supplies more than 40% of the heating in some European countries. Yet, DH is virtually non-existent in the USA.

Using heat from a central, but spatially separate, source can reduce air pollution from individual coal and oil heating systems, particularly in urban areas. When a combined heat and power (CHP) plant generates the heat, the fuel savings can also be significant.

So could the USA benefit from District Heating?

IIASA’s Fabian Wagner says the answer is yes: “The USA could save huge amounts of energy and greenhouse gases by making use of CHP technology.”

In a recent study, Wagner and collaborators used a Geographic Information System (GIS)–based approach to assess the potential for DH in the USA until the year 2030.

Using GIS, the researchers created a detailed map of the demand for space and water heating in 11 census regions, then identified clusters representing high-density heat demand and extracted the heat and hot water requirements of each cluster. Taking into account the installation and operational costs, the team also calculated the costs of DH for each state and census region.

The team found that DH could supply up to 43% of the heat in residential and commercial buildings, and could provide more than 20% of the US electricity demand. Heat distribution costs vary considerably, tending to be lower in the higher-density heat demand areas, which have greater overall heat demand.


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China's regional differences impact CO₂ targets

The high standard of living enjoyed by people in the world’s richest countries often comes at the expense of CO₂ emissions produced with technologies of low efficiency in less affluent, developing countries. What’s less apparent, says IIASA’s Laixiang Sun, is that this relationship between developed and developing can exist within a single country’s borders as in China.

Within a country like China, rich regions consume and export high-value goods and services that depend upon production of low-cost and emission-intensive goods and services from poorer regions in the same country. By tracking CO₂ emissions embodied in products traded among Chinese provinces as well as internationally, researchers find that 57% of China’s emissions are related to goods that are consumed outside of the province where they are produced. Up to 80% of the emissions related to goods consumed in the coastal provinces are imported from less developed provinces in central and western China where many low-value-added but high-carbon-intensive goods are produced.

“Without policy attention to this sort of interprovincial carbon leakage, China’s less developed provinces will struggle to meet their emissions intensity targets, whereas the more developed provinces might achieve their own targets by importing even more products from less developed provinces where climate policy is less demanding,” Sun says.

Clearly progress against emissions targets needs to be evaluated not only by production-based inventories of where emissions occur, but also by consumption-based inventories that allocate emissions to the province where products are ultimately consumed. “Consumption-based accounting of emissions could thus inform effective and equitable climate policy within China,” Sun concludes.


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Delhi to miss national air quality targets

Air quality in Delhi will not reach recommended standards under current policy measures, a new IIASA study shows.

With a population of about 16 million people, Delhi faces an acute problem of air pollution. Concentration levels of fine particulate matter (PM₂.₅) exceed the recommended guidelines set in the National Ambient Air Quality Standards (NAAQS) with adverse consequences for health. Using an integrated assessment modelling framework to analyse future air quality, IIASA researchers suggest that existing policies will not reduce air pollution to NAAQ standards even by 2030.

Using IIASA’s Greenhouse Gases and Air Pollution Interactions and Synergies (GAINS) model, researchers estimated emissions and future concentrations of PM₂.₅ as well as impacts and mitigation costs under different policy scenarios. In particular, researchers analyzed city specific policies in Delhi across the transport, industry, power, and waste sectors as well as health impacts.

Estimates suggest 22,000 extra deaths due to outdoor air pollution in Delhi in 2030 if current city specific policies continue. “Our analysis makes it apparent that air pollution is likely to have a large impact on health outcomes in Indian cities if further stringent control actions are not taken,” IIASA’s Pallav Purohit says.

Adopting advanced control technologies could reduce PM₂.₅ concentrations by about 60% by 2030. Stringent policies to control the net flow of air pollution from neighboring states would also play a crucial role in reducing pollution levels. “Achieving NAAQS requires a stringent policy portfolio that combines advanced control technologies with a switch to cleaner fuels and the control of transboundary pollution,” Purohit says.


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Governance solution to Iran’s water crisis

Iran’s severe water crisis is the result of the abandonment over the past 50 years of traditional practices in favor of modern ones, says a joint study involving IIASA’s Masoud Yazdanpanah and Michael Thompson.

For more than a decade, Iran has faced a water crisis so severe that much of its land has ceased to be productive. High rates of population growth and climate change are predicted to make the crisis even worse, with per capita water availability set to decline by half by 2050. But Iran has coped with water shortages for thousands of years, say the authors. “That Iran now seems unable to cope with such a historically familiar reality suggests that something has been lost by its abandoning of traditional practices for modern ones.”

Ancient cultural practices, respect for water, voluntary restraint, and hundreds of thousands of kilometers of qanats—gently sloping tunnels that tap ground water but do not deplete it—have enabled Iran’s traditional means of water management to ensure availability to all. In the aftermath of World War II, Iran’s agricultural and water sectors altered dramatically. New hydrological technologies borrowed from the West, it was believed, would be more than adequate in meeting Iran’s skyrocketing demand for water. This belief, the authors suggest, was misplaced and has resulted in the current super-crisis in which water is being taken out of the ecosystem much faster than it is coming in.

The remedy, the researchers suggest, is a switch away from “government”—in which state actors prescribe actions and firms and citizens comply—to “governance”—in which state actors are in a two-way and constructive engagement with actors from both the market and civil society. “Revisiting traditional wisdom and seeing how it might be reconfigured and transferred to the future is one of the approaches which could help bring Iran’s water table back to where it was before modernity took hold,” they conclude.

Geo-Wiki takes off in Australia

Volunteers in Australia are the latest to join the global Geo-Wiki project, which aims to improve data on land cover and its use. Launched in July 2013, the new Australian Geo-Wiki Branch is collaborating with the Terrestrial Ecosystem Research Network (TERN) AusCover facility and its partners.

“Geo-Wiki is a community of people that want to contribute land-related information and correct errors in existing data by providing information on their surrounding land, or (by using Google Earth) information on any place on the earth,” explains IIASA’s Christoph Perger. “Geo-Wiki is part of a growing trend to reverse the usual top-down flow of data by allowing Internet users from any region of the world to be involved in a global land cover validation exercise. This information is a vital input for various areas of research including climate change, food supply, drought, and flood prevention.”

The overall aim of AusCover Geo-Wiki is to enable any person to use their local area knowledge in improving the validation of maps produced by Australian state and federal agencies, NGOs, researchers and others. International partnerships with countries such as Australia could, Perger suggests, help Geo-Wiki succeed in its goal of building a large global community that covers all parts of the world.

“We hope to encourage as many Australians as possible to contribute their knowledge and manpower to a project that focuses on issues of significant local importance such as Australian bushfires as well as addressing major global problems.” Perger says.

Further information www.geo-wiki.org/branches/auscover

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Study in Norway identifies personality effects on fertility

Men with neurotic personality traits are having fewer children compared to previous generations, according to an IIASA study published in the European Journal of Personality. The study examined the effect of personality on how likely a person is to have children, using extensive survey and birth registry data from Norway. It also found that men who are extraverted and open tend to have more children, while women who rank as conscientious on personality tests tend to have fewer children, although these findings were constant across generations.

The study could have important implications for population dynamics at a time when fertility rates across developed countries have fallen to below replacement rates. Personality effects may be one factor contributing to the decline of fertility rates in Europe, says IIASA’s Vegard Skirbekk, who led the study, but they have not previously been studied in detail. Population changes are an important factor for projecting future changes in sustainability, climate, energy, and food security, IIASA’s core research areas.

In particular, Skirbekk notes the decline in childbearing among neurotic men—neurotic meaning individuals who tend to be moody and emotional. The study found that the effect only applies for men born after 1957. Skirbekk says that the change in these men’s fertility could be due to new norms in having children, for example that couples today wait longer to have children, and couples tend to test each other out more before committing to raising children together.

While the study only considers Norway, Skirbekk says that the findings likely apply more widely. “Norway is a leader country in terms of family dynamics,” says Skirbekk.

Further information

Skirbekk V, Blekesaune M. Personality traits Increasingly important for male fertility; Evidence from Norway. European Journal of Personality (published online 5 August 2013) [doi:10.1002/per.1936].

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The climate impact of travel

How much could travel choices contribute to climate change? Two recent studies from IIASA and CICERO (the Center for International Climate and Environmental Research – Oslo, in Norway) take a closer look at that question and provide new insights, accounting for the somewhat tricky climate impact of clouds and air pollutants.

The first study, published in the journal Environmental Science & Technology, compares trips over 500–1000 km—typical distances for business or holiday trips in Europe. It reconfirms that an aircraft passenger has by far the biggest climate impact per trip, but that a deliberate choice of public transport could reduce the impact by a factor of ten.

“Traveling alone in a large car can be as bad for the climate as flying, but driving with three in a small car could have an equally low impact as a train ride,” says IIASA researcher Jens Borken-Kleefeld, who worked on both studies.

The second study, published in the journal Environmental Science & Policy, puts single trips with individual modes into the perspective of annual travel. The researchers applied their analysis to the German population, quite typical for Europe in their travel choices. It reveals that less than half of the total climate impact from annual travel is due to the approximately 1000 day-to-day trips, most of which are by car. The analysis found that 60% of annual impact relates to the dozen medium and long-distance trips, mostly for holidays, leisure, and business purposes. Because trips with aircraft are particularly long, and per distance traveled particularly costly to the climate, the approximate 2 flights on average of the German population account for half its total climate impact from travel.

There is no silver bullet when it comes to mitigating climate change emissions from travel, says Borken-Kleefeld. Policy changes and greater fuel efficiency are one important part of the picture. But, he says, “As individuals we also need to adapt our travel choices. That’s the hard part. Ideally the climate friendly choice should be rewarded, and policy would point consistently in that direction.”

Further information


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IIASA expands global network

IIASA is pleased to welcome the Vietnam Academy of Science and Technology (VAST) as a National Member Organization (NMO) from 1 November 2013, bringing IIASA’s number of NMOs to 21. Representing the Socialist Republic of Vietnam, VAST will join a group of 20 other national science organizations that fund IIASA and help guide its research priorities.

Expressing satisfaction at its new membership, VAST stressed the importance of joining IIASA for capacity building among its science community: “Membership of IIASA by Vietnam will provide young researchers of Vietnam opportunities to access the specialized knowledge, global database and the new research methods in order to improve their research capacity and enhance their international cooperation.”

Vietnam’s membership continues IIASA’s growth in Asia, with eight countries of the continent now represented, emphasizing the Institute’s global perspective. In addition to its NMOs, IIASA collaborates with over 300 organizations worldwide, and has 3,475 alumni of which 25% are actively involved in IIASA’s work.

Eurasian economic integration

In June IIASA launched a new project to assess the prospects of economic interactions of regional alliances in Eurasia. The project aims to analyze the challenges and benefits of intra-regional cooperation and how these could be expanded to include other countries within the Euro-Asian and Asian-Pacific regions. The project, which was initiated at the request of the Administration of the President of the Russian Federation, and is a collaboration between IIASA and the Russian Academy of Sciences, IIASA’s Russian NMO.

At a launch meeting, senior participants from a variety of backgrounds including scientific, technological, and practical aspects of Eurasian economic integration, discussed the main features and challenges facing the Customs Union and Common Economic Space in relation to other regional economic integration models, in particular the European Union.

Santa Fe Institute

Leading researchers from IIASA and around the world gathered at the Santa Fe Institute (SFI) on 22–24 October to explore the current state of theory and practice in sustainability science. Citing the need for a “positive paradigm to guide a new generation of partnership between academia, government, business, and civil society,” IIASA Director and Chief Executive Officer Professor Dr. Pavel Kabat opened the workshop, co-organized by IIASA and SFI, which aimed to move forward the development of a conceptual framework for the complex field of sustainability research.

The presentations included modeling approaches that can inform strategies for sustainability and case studies that illustrated the complex challenges that social-ecological systems pose for management at the land/water/energy nexus. The discussions focused on developing testable hypotheses that integrate the insights from case studies into a predictive science of sustainability. The meeting reflected an initiative by the leadership of IIASA and SFI to build institutional cooperation between the two complementary research institutes.
New ideas for a fair globalization

In August IIASA researchers joined world leaders and academics at the European Forum Alpbach (EFA), an interdisciplinary forum that debates the most pressing global challenges. IIASA co-organized the Forum’s political symposium at which participants discussed the united global action required to resolve issues such as human security, adaptation to and mitigation of climate change, energy markets, and food security.

IIASA Director and Chief Executive Officer Professor Dr. Pavel Kabat joined Earth Institute Director Jeffrey D. Sachs, Honorary Executive Director of the Energy and Resources Institute Leena Srivastava, and Climate Group Greater China Director Changhua Wu in a plenary session to discuss the many challenges related to green growth and how this concept ties into sustainable development. This was followed by a breakout session in which IIASA researchers Michael Obersteiner and David McCollum, led discussions on integrated approaches to solving complex development problems.

IIASA also played a key role in the closing sessions of the Forum, at which IIASA and European Forum Alpbach announced the launch of a new global think tank to address the challenges of the global transformation and foster fair and sustainable development paths. EU Commission President José Manuel Barroso and Austrian Federal President Heinz Fischer added their support for the new initiative, with President Barroso emphasizing the importance for fair globalization of an integrated systemic approach.

The new global think tank will unite IIASA’s systems approaches and its scientific excellence with the Forum’s unique and historically proven power to convene meetings with leading political, economic and industrial players, thus providing a unique platform for interdisciplinary dialog.

Kabat participated in a high level retreat with H.E. Mr. Jose Manuel Barroso, President of the European Commission, Valerie Amos, UN Under-Secretary-General for Humanitarian Affairs and Emergency Relief Coordinator, Heinz Fischer, President of Austria, Jakaya Mrisho Kikwete, President of Tanzania, Franz Fischler, President of the European Forum Alpbach, Jeff Sachs, Director of the Earth Institute, and H.E. Kandeh K. Yumkella, Chairman of UN Energy. The group discussed the global transformation, including food and nutrition security and the key for poverty reduction and growth.

For Kabat’s view from inside Alpbach see his recent post at blog.iiasa.ac.at
The future of water research

Experts from IIASA’s flagship project—the Water Futures and Solutions Initiative—participated in the Budapest Water Summit in October. Professor Dr. Pavel Kabat, IIASA’s Chief Executive Officer and Director, spoke at the opening ceremony at which 1200 participants, including UN Secretary General Ban Ki-moon and Hungarian President János Áder, gathered to discuss potential solutions to ongoing worldwide water challenges. Kabat stressed the need for integrative science, a vision of the future, and for new types of partnerships. These are key elements of the Water Futures and Solution initiative and are essential to tackle global water challenges. A new book was launched at the Summit. The book, by the Gulbenkian Think Tank on Water and the Future of Humanity, is co-authored by Kabat and enlightens readers on changes needed in the way society accesses, provides, and uses water, food, energy, and other goods and services, as well as exploring the changes needed in managing this complex system.

IIASA connects to Vienna academics

IIASA has established new partnerships with the Vienna Institute for International Economic Studies (WIIW) and University of Natural Resources and Life Sciences, Vienna (BOKU). Both partnerships aim to link research and education programs and sets groundwork for further future collaborations. In particular WIIW will play an important role in IIASA’s newly launched Eurasian Economic Integration Project.

IIASA launches Nexus blog

This summer IIASA launched a new tool in our communications channels, Nexus. The new research blog serves as a forum for IIASA researchers to share their work, tools, and findings, and to foster communication with policymakers, journalists, and the general public. Recent posts have included a young scientist’s experience in IIASA’s new Southern African Young Scientists Summer Program and ESM researcher Linda See’s view on citizen science.

A network for solutions

Kabat has been appointed to the Leadership Council of the Sustainable Development Solutions Network (SDSN). This global initiative, established by UN Secretary-General Ban Ki-moon, mobilizes leaders from academia, business, civil society, and other development organizations to promote problem solving and practical solutions for the pressing challenges of sustainable development.

Stark statement on climate

Professor Kabat and IIASA Deputy Director Nebojsa Nakicenovic are founding members of the Earth League, a global initiative of prominent climate scientists. Prior to the publication of the latest IPCC report on climate change, the Earth League issued a statement warning that if we continue on our current business-as-usual path, we are on track for a 4°C warmer world within this century—2°C higher than the warming deemed acceptable to avoid dangerous climate change.

IIASA named a top think tank

IIASA was placed second in the European Category of the 2012 Climate Think Tank Ranking, published earlier in 2013 by the International Centre for Climate Governance (ICCG). The report is the first ranking of the most influential institutions working in the field of climate change economics and policy.
My experience in the Southern African YSSP

By Valentina Prado, Arizona State University

I am a PhD student in Sustainable Engineering at Arizona State University (ASU). I was born in Cali, Colombia, and when I was in high school my family emigrated to Canada seeking educational opportunities for me and my sister. I currently work in Dr. Thomas P. Seager’s research group, studying decision analysis methods for environmental management problems. In December 2012 I traveled to South Africa to participate in the first-ever Southern African Young Scientists Summer Program (SA-YSSP), a spin-off of IIASA’s well-known YSSP.

My project in the SA-YSSP evaluates environmental, social, and economic aspects of possible energy pathways in South Africa using MCDA tools—which allow us look for solutions to complex problems with many trade-offs. We examine how thermo-electric power is produced in South Africa, and how different generation technologies perform economically, environmentally, and socially. For each energy pathway, we take into account environmental impacts concerning water and air quality, social impacts such as job creation and cost of production.

The SA-YSSP was one of the most amazing and productive experiences of my life. I traveled to a place that otherwise I would have not gone, I got to work on a really cool project with renowned people in the field, and I got to meet wonderful young scientists from all over the world. I also learned more about the IIASA community and discovered that it is something that I will consider taking part in during my doctorate or after. It was three unbelievable months where I celebrated my birthday with friends from over 10 different countries and felt at home, learned about South Africa’s history, saw a penguin, ran a 5km race, ate bobotie, and got to pet two-week old baby lions. I would like to thank all the sponsor organizations and staff for organizing the SA-YSSP program, and allowing me the opportunity to participate.

Article adapted from a post on the IIASA research blog Nexus: blog.iiasa.ac.at

Further information
Southern African Young Scientists Summer Program: www.iiasa.ac.at/sa-yssp
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YSSP participant wins IPCC fellowship

Clark University PhD candidate Pheakkdey Nguon has been awarded the Intergovernmental Panel on Climate Change (IPCC) fellowship to continue work he started as part of the 2012 YSSP. Pheakkdey’s research focuses on the saliency, credibility, and legitimacy of the UN’s Reducing Emissions from Deforestation and Degradation (REDD+) projects to reduce the impacts of climate change, reduce deforestation and degradation, and improve sustainable livelihood development in Cambodia—as perceived by the various groups of stakeholders.

For his research, Pheakkdey plans to observe REDD+ policy dialogs, interview stakeholders, and collect archival documents of the three REDD+ project sites in Cambodia. The $40,000 IPCC grant will fund one year of that fieldwork as well as one year of his dissertation writing. He says, “This research is relevant to the ongoing debate on how scientific knowledge is being received, perceived, and reconfigured in environmental governance policy that spans multiple scales of implementation and involves various groups of stakeholders.” In addition, says Pheakkdey: “This study should contribute to the debate on why certain groups of stakeholders have been supportive, while others have been critical, of the implementation of REDD+ projects in developing countries.”

Pheakkdey, originally from Cambodia, also received the 2012 IIASA Annual Fund, which supports participation in the program by exceptional students from developing countries. He says: “As a student from Cambodia, I do not think it would have been possible for me to be part of this superb program at IIASA without the support from the Annual Fund donors.”

Further information
Young Scientists Summer Program: www.iiasa.ac.at/yssp
• Annual Fund: www.iiasa.ac.at/annualfund
Aleksandra Cofala cofaleks@iiasa.ac.at

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Energy for decent living: What will it take?

Q&A with IIASA Research Scholar Narasimha D. Rao

What are the major questions that you address in your work?

Today over 1.4 billion people lack electricity, mainly in rural areas, and billions of rural households in South Asia and sub-Saharan Africa continue to use solid fuels for cooking even when they have market access to modern fuels. I am interested in the chronic nature of this energy poverty and how it affects livelihoods and human development. Energy needs for development can also conflict with the need to mitigate climate change. How can we find low-carbon opportunities for meeting these needs in different countries, leapfrog over past unsustainable development pathways, and find fair and practical ways to share responsibility for mitigating climate change?

In my research, I examine how energy use contributes to a range of living standards, including health, education, and infrastructure. I also examine the impacts of raising living standards on climate change, and vice versa. If everyone lived in decent homes with basic amenities, how much would emissions grow and when? If countries implemented climate policies that raised energy prices, how would that exacerbate poverty and opportunities to access modern energy services?

In a recent publication, you examined the relationship between decent living standards and energy emissions in different countries. What did you find?

One of our major findings is that different countries require vastly different amounts of energy to provide the same living conditions. For example, providing the same living conditions in the USA compared to India requires multiple times the amount of energy per person, although India has far to go to actually provide these standards to all its inhabitants. This has important implications for development policy, future energy planning, and more broadly for climate change. On a global scale, the energy needs for decent living standards provide a basis for assessing the impacts of poverty alleviation on climate change and for determining the basic emissions that developing countries can reasonably claim as essential in future agreements on mitigating climate change.

What do people tend to be surprised about when you talk about your research?

We know from IIASA’s work in the Global Energy Assessment that the climate impacts of providing basic services, such as clean cooking, electricity, and lighting, are negligible. However, the indirect energy needs for building the infrastructure for other essential services and amenities are perhaps more significant, and their effects on climate are yet unknown. Second, most people understand that combating climate change means shifting to renewable sources of energy and cutting our individual energy consumption. However, my research highlights the extent to which policy choices rather than individual consumption decisions influence energy resources.

How did you get interested in this topic?

I grew up in Mumbai surrounded by stark poverty and growing affluence. The desire to understand these disparities led me to development work. My interest in energy was sparked in university, when I read books on the limits to growth and how energy lay at the center of humans’ exploitation of natural systems.

Why did you come to IIASA?

I came to IIASA as part of the post-doc program in 2011. I knew IIASA’s reputation from its influential contributions to the IPCC and because several of my PhD colleagues had participated in the YSSP. IIASA’s approach—using interdisciplinary scientific research to address policy challenges, including both global climate change and poverty—fits my style: I tend to think in terms of big picture issues and systems interactions.

Narasimha D. Rao is a research scholar in IIASA’s Energy program. His research examines the interplays between energy access, poverty, and climate change.

Further information


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