International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at

# options

winter 2011/2012

# Human wellbeing

# Sustainable development

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Director, IIASA

# Human wellbeing and sustainable development

This issue of *Options* brings together two areas of IIASA's work: research into poverty and equity; and research on sustainable development, which will feed into Rio+20, the United Nations Conference on this topic.

Eradicating poverty is one of the greatest challenges of our time. In 2005 1.4 billion people lived under the international poverty line of US$1.25 a day, according to the World Bank. Poverty is not only an economic concern, but it also is closely related to lack of education, poor health, degraded environment, and lack of access to resources including energy and water. Historically, development and economic growth have been key to bringing significant numbers of people out of poverty. But such growth must be sustainable if today's world is to be fair to future generations and not exceed the planetary boundaries, which could lead to dangerous environmental change.

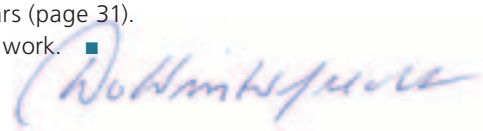
For development and economic growth to be sustainable, we need to develop policies that simultaneously consider economic development, social development, and environmental protection. Indeed this integrated, long-term, and solution-oriented perspective is central to IIASA's research strategy of using systems analysis to study three interlinked and complex global problem areas—Poverty and Equity; Food and Water; and Energy and Climate Change.

This *Options* gives a flavor of IIASA's work in the Poverty and Equity research area. The multiple benefits of education to improve not only people's wealth but also their health and wellbeing at both the individual and the national level (page 14) show the value of developing policies that have multiple purposes. Education can also help people adapt to climate change (page 23). Case studies from Nepal show how foreign aid can both help and hinder a country's development (page 12). And using behavioral games research to examine how to regulate the selfish actions of individuals that jeopardize common goods, such as clean air, civil security, fish and game stocks, the Internet, or even the global climate offers a range of insights (page 18).

Tackling issues of poverty and equity is also fundamental to sustainable development. IIASA (with funding from the United Nations Population Fund) brought together over 20 experts to discuss how population factors promote or impede sustainable development. Their recommendations will feed into Rio+20 (page 9). Reducing energy poverty is a key part of the UN Secretary-General's Sustainable Energy for All Initiative, which will announce a range of commitments at Rio+20. IIASA's Deputy Director is one of the advisors for this initiative (page 4), and some of IIASA's recent research aims to analyze the people on the receiving end of our current aspirations to expand energy access (page 20).

On a personal note, this *Options* is my last as IIASA's Director. Thanks to the efforts of all my colleagues and with the support provided by IIASA's Council and our National Member Organizations, I leave the Institute stronger with a clear vision laid out in IIASA's Strategic Plan for 2011 to 2020 and an accompanying research plan for the next five years. I am also very pleased that Brazil and Malaysia joined IIASA as our newest members and that our finances are in excellent shape. Next February Professor Pavel Kabat will take over the helm as the new Director of IIASA. He and I have had many conversations over the past months guaranteeing a smooth transition and a future that builds on the foundation that we all laid together in the past three years (page 31).

I hope you enjoy reading about IIASA's work. ■



## About IIASA

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

IIASA's scientists research
- energy and climate change;
- food and water; and
- poverty and equity.

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

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

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

Austria, Brazil, China, Egypt, Finland, Germany, India, Malaysia, Japan, Netherlands, Norway, Pakistan, Republic of Korea, Russia, South Africa, Sweden, Ukraine, United States of America.

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IIASA

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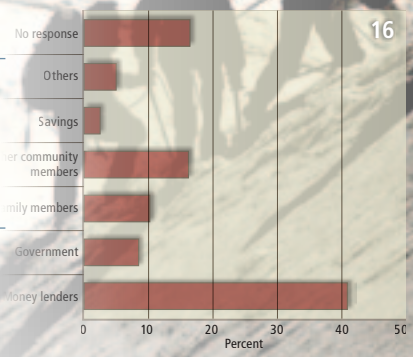





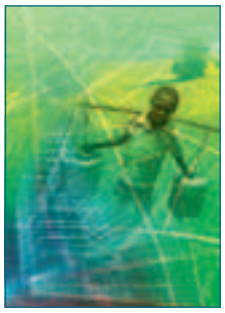

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EMISSION SCENARIOS

## A 2°C global temperature limit

A recent study by a team of researchers, including IIASA's Keywan Riahi and published in *Nature Climate Change*, shows how challenging it will be to limit global temperature rises to 2°C, thereby avoiding dangerous climate change. The researchers reanalyzed a large set of published greenhouse gas emission scenarios and found that to have a greater than 66 percent chance of staying below 2°C, global emissions peak between 2010 and 2020 and then fall to 41–46 GtC by 2020 and continue to fall.

Global emissions are currently 48 GtC and rising. The study concluded: "If the mechanisms needed to enable an early peak in global emissions followed by steep reductions are not put in place, there is a significant risk that the 2°C target will not be achieved." ■

Rogelj J, Hare W, Lowe J, van Vuuren DP, Riahi K, Matthews B, Hanaoka T, Jiang K, Meinshausen M (2011). Emission pathways consistent with a 2°C global temperature limit. *Nature Climate Change* 1:413–418.

NEW IIASA ADVISORY ROLE

## New UN Group to implement Sustainable Energy for All initiative

IIASA's Deputy Director Nebojsa Nakicenovic has been appointed to the Technical Group of the UN Secretary-General's High-level Group on Sustainable Energy for All. The Group will develop an action agenda to mobilize stakeholders in support of the three interlinked global targets of the Secretary-General's Sustainable Energy for All Initiative.

The three objectives are: (1) ensuring, universal access to modern energy services; (2) doubling the rate of improvement in energy efficiency; and (3) doubling the share of renewable energy in the global energy mix. Nakicenovic presented options for achieving the Secretary-General's targets at the Group's inaugural meeting in New York in September and participated in the second meeting in Oslo on 9 October.


UN Photo | Eskinder Debebe

**UNITED NATIONS SECRETARY-GENERAL BAN KI-MOON** addresses the international conference "Energy for All: Financing Access for the Poor" in Oslo, Norway.

At the Oslo "Energy for All" conference, Secretary-General Ban Ki-moon stressed the importance of the ambitious yet achievable targets: "Together, they can help to revitalize the global economy, combat climate change, and go a long way toward ensuring equal opportunity for all." A range of commitments and partnerships that contribute to the action agenda of the Group will be announced at the United Nations Conference on Sustainable Development (Rio+20) in June 2012. ■

www.sustainableenergyforall.org

CARBON SINKS

## Forests play dominant role in removing atmospheric carbon

Established forests across the globe remove about 2.4 billion tons of carbon annually from the atmosphere, accounting for virtually all of the carbon absorbed by terrestrial ecosystems, according to a new study by a team of researchers from IIASA and 13 research institutions from around the globe. The findings, published in *Science* are the first to specifically identify the amount of carbon absorbed by boreal, temperate, and tropical forests; and show that forests have removed about one-third of the fossil fuel emissions for the period of 1990 to 2007.

"The study found that carbon uptake in tropical forests not affected by human activity was more than a billion tons per year, and a further 1.6 billion tons of carbon is absorbed by the regrowing of tropical forests," said IIASA's Anatoly Shvidenko, one of the study's co-authors. "However, carbon emitted to the atmosphere from deforestation in the tropics exceeds both the above sinks. Boreal forests, which predominate in Russia and Canada, took up about 500 million tons of carbon annually, while temperate forests were responsible for about 780 million tons." ■

Pan Y, Birdsey RA, Fang J, Houghton R, Kauppi PE, Kurz WA, Phillips OL, Shvidenko A, Lewis SL, Canadell JG, Ciais P, Jackson RB, Pacala SW, McGuire AD, Piao S, Rautiainen A, Sitch S, Hayes D (2011). A large and persistent carbon sink in the world's forests. *Science* 333(6045):988–993.

POPULATION PROJECTIONS

## The day of 7 billion

The United Nations chose 31 October 2011 as the symbolic date for when the world's population reaches 7 billion. IIASA's demographers believe there is a 95 percent chance that the world's population would reach 7 billion between January and July of 2012, even when using the UN 2010 base line population figures. IIASA's own projections suggest an even later point in time. Why is there such uncertainty over the timing of this population milestone?

The sizes of many populations today are not known with high accuracy, including the populations of China, India, and many countries particularly in sub-Saharan Africa. As the most recent census information tends to be a decade old (from the 2000/2001 round of censuses), the fertility assumptions used to project the populations from 2000 to 2011 also play an important role, particularly when they are highly uncertain and concern countries with large populations.

Small differences in assumptions about future fertility, mortality, and migration, can lead to vastly different projections which is why IIASA's demographers provide probabilistic projections. For example, they compute that there is a 60 percent chance that the world's population will reach 8 billion between 2024 and 2033. Their figures also show that there is an 84 percent chance that the world's population will peak this century.

"However, it is not simply the number of people that matters but more so their distribution by age, education, health status and location that is most relevant to local and global sustainability," points out IIASA's Wolfgang Lutz (see page 9).

IIASA is currently producing an entirely new set of science-based world population projections by age, gender, and level of education for all countries in the world to which already more than 550 population experts from around the world have provided input. ■

Scherbov S, Lutz W, Sanderson WC (2011). The uncertain timing of reaching 8 billion, peak world population, and other demographic milestones. *Population and Development Review* 37(3):571–578.

VIENNA ENERGY FORUM

## Universal energy access can secure growth and freedom

Participants at a major international event on energy in Vienna in June called for bold steps and strategic public-private partnerships to guarantee universal energy access by 2030, including by expanding the use of renewable energy sources.

The three-day Vienna Energy Forum in the Hofburg Palace was organized by the United Nations Industrial Development Organization (UNIDO), the Austrian Federal Ministry for European and International Affairs, and IIASA. It brought together more than 1,200 participants from 125 countries including heads of state, policymakers, experts, civil society, and the private sector.

Speaking at the Forum, former Governor of California Arnold Schwarzenegger said that universal energy access was not "just about lighting a dark room, or cooking on a better stove. It's about the freedom that energy—and especially renewable energy—gives us."

The event coincided with the pre-launching of *Global Energy Assessment*. ■

SHORT-LIVED CLIMATE FORCERS

## Near-term climate protection

Reducing short-lived climate forcers—black carbon, ground-level ozone, and methane—in South Asia would improve health and crop production in the region as well as help protect the regional climate from rapid change. This was one of the main conclusions from the Joint Bangladesh–Sweden Policy Seminar for the South Asian Region on Near-term Air Quality and Climate Benefit held in Dhaka, Bangladesh on 17–18 October.

Photo: Stockholm Environment Institute

**BANGLADESH–SWEDEN POLICY SEMINAR** Participants discussed why and how to improve near-term air quality and climate benefit in South Asia.

IIASA researcher Zbigniew Klimont presented the latest findings from IIASA's GAINS model to the high-level audience that included the Bangladeshi Minister of Environment and Forests and the Swedish Minister of the Environment. Klimont's analysis of the technical and regulatory measures to control emissions of short-lived climate forcers (SLCFs) showed that concentrating efforts on the full implementation of a small number of tried and tested mitigation options would address about 90 percent of the reduction potential for radiative forcing caused by SLCFs. These results are also used in a new UNEP study on "Near-term climate protection and clean air benefits: Actions for controlling short-lived climate forcers."

UNEP's Chief Scientist and IIASA alumnus, Professor Joseph Alcamo, provided a preview of the results from the forthcoming UNEP report at the meeting. The study, which includes chapters from IIASA's air pollution experts, identifies national, regional, and global actions that largely build on existing instruments and institutions to reduce SLCFs and so reduce both major sources of air pollution and slow down the tempo of near-term global warming. The study will be published in advance of the UN climate change negotiations held in Durban in late 2011.

The seminar was organized by the Bangladeshi and Swedish Environment Ministries and the Stockholm Environment Institute. ■

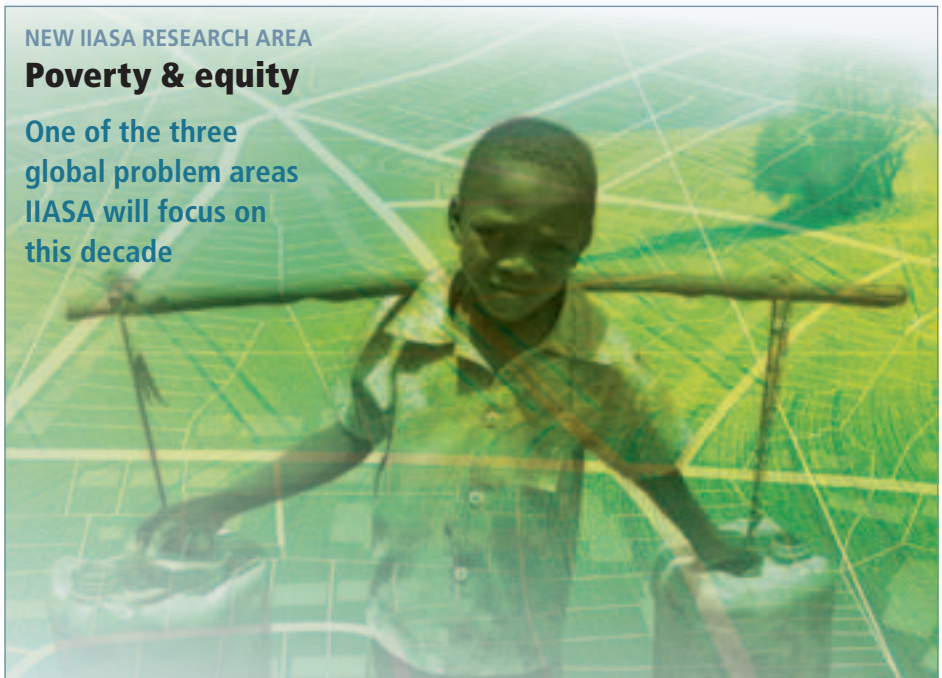
www.sei-international.org/press/press-releases/2110

# research in the pipeline

NEW IIASA RESEARCH AREA

## Poverty & equity

**One of the three global problem areas IIASA will focus on this decade**



IIASA's new focus on Poverty and Equity as a research theme recognizes the complex, integrative nature of poverty and is in accord with ongoing efforts to reach, by 2015, the United Nations Millennium Development Goals of eradicating extreme poverty and hunger, as well as improving global health and education.

Institute researchers are exploring an approach to combating poverty that emphasizes wellbeing and happiness indicators instead of the more traditional and restrictive indicators of individual income and wealth (see page 30). In developing the research theme, IIASA researchers recognized the complex and integrative nature of poverty, which cuts across income and education levels and is tied to health, the environment, and access to resources including energy and water.

IIASA's expertise in dynamic systems and multi-criteria decision analysis are being used to develop advanced tools to study the dynamics of poverty, as well as the policies needed to combat it. An important part of this work is to link poverty with inequity through strategies that reduce poverty by stimulating growth without increasing inequality. The research also identifies the routes to economic growth that do not increase environmental or climate change-related problems.

Specific topics linking poverty and equity to research throughout IIASA's programs are:

- **Energy poverty** Millions of people are trapped in poverty because they do not have access to electricity. The dilemma is how to improve access to energy while at the same time reducing greenhouse gas emissions.
- **Poverty & ecosystems** Poverty is often linked to ecosystems degradation—cutting down forests for fuel, for example. Breaking that link is critical.
- **Poverty, inequity, education** Developing policies that improve education can reduce both poverty and inequality. Although poverty would appear to be a problem primarily for low-income countries, most poor people live in middle-income countries. This underscores the global need to emphasize educational equity in fighting poverty.

A growing theme in research on poverty is the issue of poverty traps, which arise when self-reinforcing mechanisms limit the capacity of the poor to emerge from impoverished circumstances. IIASA has particular expertise in studying poverty traps through its integrated research on renewable resources, education, and health. Researchers are focusing not only on effective policy solutions for well-defined poverty traps, but also on identifying the common features of the traps in order to develop a more comprehensive approach to eliminating them (see page 16). ■

IIASA's Strategic Plan 2011–2020 at www.iiasa.ac.at/docs/strategic_plan.html

MARKET ACCESS

## Increasing food security

Recent surges in food prices worldwide have made clear to the international aid and economic development communities that despite technical progress in growing and processing food, overall improvements in food availability and security are not guaranteed because of increasing economic instability, resource scarcity, and climate change.

Because traditional supply-side approaches are no longer sufficient to enhance food security, the European Commission is launching the €8 million FoodSecure project. IIASA's Ecosystems Services and Management Program, working with a consortium of other universities and institutes, will use the GLOBIOM and MIRAGE models to develop the social dimension of economic modeling. The models will allow researchers to examine different categories of households as well as other agents affecting food security according to revenue levels, occupation, gender, and geographical location.

© Manoocher Deghati/IRIN

With the new modeling framework, researchers will be able to measure the consequences of land use policies in terms of farm income and understand in more detail how different types of rural and urban households are affected by macroeconomic and sectoral (industrial, commercial, agricultural, and residential) land use policies. The goal is to design policies to eliminate hunger not only through increased food supplies, but by improving access to markets and reducing poverty. ■

WATER SHORTAGE

## Glacial retreat

As climate change accelerates glacial melting in the Tropical Andes, millions of people already suffering from poverty in Bolivia, Ecuador, and Peru face shortages of drinking water, changes in the way they farm, significant reductions in hydropower, and severe economic disruptions in populations.

IIASA is contributing to the PRAA project (Project Adaptation to the Impacts of Rapid Glacier Retreat in the Tropical Andes), an international effort to help ensure that the national and local governments in those countries can adapt to the rapid glacial retreat by incorporating its anticipated effects into their regional and local economic development projects.

IIASA researchers in the Ecosystems Services and Management Program are developing the methodology for creating comprehensive baseline data that is critical for understanding the extent and speed of the ecological changes under way in those countries. The data is being tailored to provide information specific to several climate change adaptation projects already taking place in the Andes. ■

www.careclimatechange.org/adaptation-initiatives/praa


© Brad Mering | Wikimedia

DEMOGRAPHIC THEORY

## Adapting to climate change

There have been few studies on the likely impacts of climate change on human wellbeing. IIASA researchers working on the project FutureSoc (Forecasting societies adaptive capacities to climate change) aim to better define the likely consequences of future climate change on human societies and to estimate their ability to adapt to changes in the future.

The EC-funded study examines long-term projections of human capital (population by age, sex, and education level) as a key element of adaptive capacity. It draws lessons from multi-national studies of past "vulnerability and adaptation" events—the recurring Sahelian drought in North Africa, Hurricane Mitch striking Central America in 1998, and the 2004 Asian tsunami.

FutureSoc is intended to advise policymakers on what paths to follow and steps to take in implementing adaptation strategies. The project includes case studies of the future adaptive capacity of the Phuket region of Thailand, India's Nicobar Islands, and the island of Mauritius in the southwest Indian Ocean.

The goal is to develop a new demographic theory of long-term social change with predictive power. The project is built on previous work by Wolfgang Lutz, FutureSoc's lead investigator, and other IIASA researchers. ■

SATELLITE IMAGING

## Predicting agricultural productivity

The increasing world population, combined with an increase in natural disasters and climate instability caused by global warming, will put unprecedented pressure on land resources, particularly land for agricultural production.

IIASA is a partner in the 30-month EC-funded ISAC (Information Service on Agricultural Change) project that will use high-frequency, high-resolution imaging from new satellites to improve agricultural monitoring and model future agricultural productivity under different climate change scenarios.

The project will develop three basic services: a satellite mapping service that will produce vegetation maps with greater spatial detail than is currently available; improvements to current capabilities in drought-related crop damage and risk assessment; and provision of both short- and long-term crop yield forecasts based on global climate change predictions.

Institute researchers are developing a core information service for detecting agricultural change as part of the project. Data from the EPIC crop model and the GLOBIOM land use change model are being integrated, so that researchers can better estimate the impact of climate change on agriculture. ■

www.gmes-isac.info

NEW STRATEGIES

## Sustaining livestock

As the production of livestock products, primarily meat, is expected to more than double by 2050 to keep pace with the demands of a growing world population, IIASA researchers are working with the EC-funded AnimalChange project to create scenarios that will allow policymakers to better understand what impact climate change is likely to have on livestock production in Europe, northern and sub-Saharan Africa, and Latin America.

IIASA's Ecosystems Services and Management Program (ESM) researchers are developing models and databases to examine two issues: how the livestock sector can best adapt to climate change, and how to mitigate the significant greenhouse gas emissions from livestock, particularly methane and nitrous oxide.

To develop mitigation and adaptation options, ESM researchers are first establishing a "business- as-usual" baseline to determine what future livestock production will look like if current production practices continue. The business-as-usual scenarios will then be analyzed under a host of influences, including changes in land and water use, developments in the agricultural markets, and changes to livestock production systems. That analysis will guide policymakers in deciding which mitigation and adaptation strategies are most likely to succeed. ■

www.animalchange.eu

RISK FINANCING

# Fiscal planning for extreme events

## IIASA analysis has supported the Mexican government in trying to identify how best to prepare financially for a major natural disaster

In 2006 Mexico became the first transition country to transfer part of its public-sector natural catastrophe risk to the international reinsurance and capital markets. This decision came just over 20 years after the 1985 Mexico City earthquake had highlighted the shortcomings of after-the-event approaches for coping with disaster and associated losses. Mexico adopted its new approach with support from an IIASA analysis of the different options for risk financing.

More than 9,000 people lost their lives in the 1985 Mexico City earthquake and estimates put the direct economic cost of the disaster at about $8 billion (in 2010 prices). Lying as it does within one of the world's most active seismic regions and in the path of hurricanes and tropical storms, Mexico's population and economy are highly exposed to natural hazards such as earthquakes, droughts, hurricanes, mudslides, and volcanic activity.

Severe natural disasters (the type likely to occur infrequently but at great cost) represent large fiscal liabilities for the Mexican government. Hence, momentum gathered through the 1990s for the Mexican federal government to respond to this challenge. Initially, in 1996 the authorities established a special Natural Disaster Fund allocation in the federal budget called the "Fonden." But the series of natural disasters that has occurred in Mexico in recent years has forced the government to look at alternative insurance strategies.

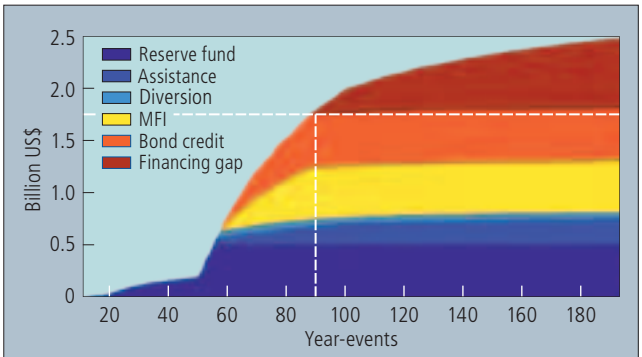
"From 2000 the Mexican government began collecting data to assess the exposure of its assets to losses from earthquakes and to analyze different financial instruments that could be used to transfer the risk to the markets," explains Victor Cardenas who worked at the Mexican Ministry of Finance at the time and currently is a catastrophe risk financing expert.

In 2004 the Ministry of Finance began working with IIASA to examine the economic costs and benefits of investing public resources in two risk transfer instruments—reinsurance (where reinsurers hold sufficient reserves to meet claims in the event of disasters and typically transfer a part of their risk to other companies) and catastrophe bonds. Cat bonds, as they are also known, allow the investor to receive an above-market return when a specific catastrophe does not occur, but the investor must share the insurer's or government's losses by sacrificing interest or principal following a disaster event. Unlike reinsurance, post-event payments do not stem from insurance company reserves but from global capital markets.

Analysis of these two instruments was informed by IIASA's catastrophe simulation model (CATSIM) which provides a stylized interactive model-based framework to assist public policymakers of exposed and vulnerable countries to design *ex ante* risk financing strategies. As Cardenas points out: "For Mexico, CATSIM provided a clear picture of the different layers of risks posed by earthquakes to the public finances and helped identify which risks could be transferred to the international market at an acceptable cost."

Using CATSIM and other detailed information, analysts examined the relative merits of reinsurance as opposed to catastrophe bonds. While they are to some extent substitutable options for transferring sovereign disaster risk, there are differences in terms of their cost and credit risk. The interactive CATSIM tool gave the Mexican authorities the opportunity to look at different assumptions and parameters regarding risk financing alternatives, and inform the decision taken in 2006 to issue a catastrophe bond to cover the risk of a really major earthquake event. Further catastrophe bonds were issued in 2009 that also covered risks from major hurricanes.

Have cat bonds proved a success? "Fortunately, Mexico has not experienced a major disaster in the areas covered by the bonds," says Cardenas. "However, the attractiveness of the bonds for international investors was so great that they were oversubscribed, which has ensured that the premiums the government pays on the bond are below the market average for other cat-bond market players." As a result, Mexico's experience could set an important precedent for protecting highly exposed developing and transition country governments against the financial risks of natural catastrophes. ■




**ASSESSING MEXICO'S FINANCIAL VULNERABILITY TO EARTHQUAKES** The graph, generated by IIASA's CATSIM model, identifies the costs of disasters to the public sector for earthquakes of varying magnitude (presented as one in 20, 50, 100, and so on year-events). The colored areas show the available financing sources for rebuilding infrastructure and providing disaster relief to citizens. These sources comprise a government reserve fund (FONDEN), international assistance to be provided by the international community, budget diversion, and domestic credit via government bonds. The analysis suggested that beyond an amount of approximately $1.7 billion, which corresponds to an event with a likelihood of occurring once in 91 years, the government would be unable to finance these contingent liabilities, and this is shown as the financing gap. ■

**Further information** Cardenas V et al. (2007). Sovereign financial disaster risk management: The case of Mexico. *Environmental Hazards* 7(1):40–53 [doi:10.1016/j.envhaz.2007.04.005]. ▪ Michel-Kerjan E et al. (2011). Catastrophe Financing for Governments: Learning from the 2009–2012 MultiCat Program in Mexico. OECD Working Papers on Finance, Insurance and Private Pensions, No. 9 [doi:10.1787/5kgcjf7wkvhb-en].

**Mr. Victor Cardenas** is a consultant specializing in climate change and catastrophe risk management. He led the team in Mexico's Ministry of Finance that guided the establishment of the first catastrophe bond in 2006 and advised the Mexican government on the 2009 catastrophe bonds.

HUMAN CAPITAL

# Demographic challenges for sustainable development

**Convinced by the need to integrate the three pillars of sustainable development (economic development, social development, and environmental protection), IIASA (with funding from the United Nations Population Fund) brought together over 20 experts to discuss how population factors promote or impede sustainable development. The experts, including Indian-born economist, Sir Partha DasGupta, Chinese demographer, Dr. Peng Xizhe, and former Chief Scientific Adviser to UK Government, Sir David King, recommend five broad actions to Rio+20, the United Nations Conference on Sustainable Development. This is their statement.**

## The Laxenburg Declaration on Population and Sustainable Development

*Statement of Global Expert Panel (October 2011)*

"Human beings are at the centre of concern for sustainable development." This was the view expressed in the 1992 Rio Declaration on Environment and Development, which we reaffirm. Therefore, consideration of the changing numbers, characteristics, and distributions of human beings on the planet must be at the core of any serious analysis of challenges and opportunities for sustainable development.

Any analysis of sustainable development must recognize the differences among people in terms of their impacts on the environment and their vulnerabilities to risk, which depend on their age, gender, location, and other socioeconomic characteristics. New evidence indicates that human capital, enhanced through education and health (including reproductive health), can make a substantial difference in people's contributions to sustainable development and their capacity to adapt to environmental change.

Only by accounting for and addressing demographic factors will it be possible to achieve sustainable development. Investments in human capital should be emphasized alongside other measures to promote sustainable development, a "green economy," and adaptation to environmental change.

### The current demographic divide

Over the last half century, world population has more than doubled, from 3 billion in 1960 to 7 billion today. Because of the young age structure in low- and middle-income countries, continuing population growth in the coming decades is a virtual certainty, even in the unlikely event that birth rates fall precipitously in these countries. Consequently, the world's population will very likely be between 8 and 11 billion by 2050, depending primarily on the speed of future fertility decline. But this population growth will not occur evenly across the globe.

Indeed, traditional demographic groupings have broken down. While the population of sub-Saharan Africa is likely to increase by a factor of three to five over the course of this century, Eastern Europe is already on a declining trajectory. China, due to its very rapid recent fertility decline, is likely to reach a peak population in 10–20 years and then enter an era of population decline. Along with China and other developing countries with low fertility, the industrialized countries face the challenges of population aging and changing living arrangements, including the adjustments that need to be made to social security and health care systems. Meanwhile, life expectancies are on the rise in most countries, even those worst hit by HIV/AIDS. Mortality decline is a long-term trend that research indicates will likely continue, both in countries where people now live the longest and in those where life expectancy is much shorter. Levels of mobility, urbanization, and education also differ substantially among and within regions, adding significant dimensions to the demographic divide.

Nearly all of the world's population growth will occur in the cities and towns of today's poor countries, primarily because of rural-to-urban migration combined with high national population growth. Meanwhile, the populations of many low-fertility countries will be declining. The demographic divide between rapidly growing urban populations in poor countries and slow growth or decline in industrialized countries is historically unprecedented. ▶

Photo © Br Ramana Reddi | Dreamstime.com

## EXPERT PANEL MEMBERS

The expert meeting, held at IIASA from 30 September to 1 October 2011, included the following members, all of whom attest to this statement:*

**WOLFGANG LUTZ** and **WILLIAM BUTZ**
(Meeting Coordinators); World Population Program, IIASA, and Wittgenstein Centre for Demography and Global Human Capital

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*Clockwise, from bottom right*:
Wolfgang Lutz, William Butz, Sir David King, Sergei Scherbov, Demissie Habte, Sir Partha DasGupta, Paulina Makinwa-Adebusoye

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These demographic differences fundamentally affect people's contribution to environmental burdens, their ability to participate in sustainable development, and their adaptability to a changing environment. Different demographic challenges require differentiated responses. The developmental challenges are by far the most significant where population growth and poverty are the highest, education is the lowest, and vulnerabilities to environmental change are the greatest. Negative impacts on the environment tend to be the most significant where people's material consumption levels are highest.

### Demographic factors in the transition to a green economy

Efforts to meet the legitimate needs and aspirations of rapidly growing populations in developing countries and to reduce poverty will entail higher consumption and production; if inappropriately managed, these efforts will further increase pressure on the natural environment. As well as increasing carbon emissions through fossil fuel combustion with current technologies, population growth also often contributes to depletion and degradation of essential life-support systems, including deforestation, depletion of aquatic resources, air pollution, loss of biodiversity, and degradation of agricultural lands. It is important to reduce such negative impacts on the environment and the global climate in order to derive multiple benefits for local as well as global sustainable development.

Fertility decline in high-fertility countries, by slowing population growth, makes many environmental problems easier to solve and development easier to achieve. Some of these benefits operate through the changing age structure that declining fertility induces. If the number of children relative to the working-age population is reduced, the demographic dependency ratio falls, creating an opportunity to increase investments in health, education, infrastructure, and environmental protection. It has been shown empirically that this demographic bonus, if properly utilized, can help propel countries out of poverty. Research in the last decade suggests that education increases people's life opportunities in general, greatly contributes to technological and social innovation, and creates the mental flexibility required for a rapid transition to a green economy. This applies to both low- and high-income countries. Hence, the enhancement of human capital from early childhood to old age through formal and informal education and life-long learning is now known to be a decisive policy priority.

The majority of the world's population now lives in urban areas, and urbanization is certain to continue. As recent research has affirmed, urbanization often improves people's economic productivity and their access to education,

health, and other services. However, urban population growth also presents challenges for urban planning and good governance: challenges that are especially acute in environmentally fragile locations. For the African and Asian countries where urban growth is most rapid, reducing vulnerability will require the urban transition to be achieved without the creation of undue environmental hazards or social inequality.

## Investing in the tide of global youth

A striking demographic challenge is the rapidly increasing tide of young people entering the labor markets of developing countries with high aspirations but limited opportunities to find productive employment. Globally, there are 1.2 billion young men and women aged 15–24, the typical age for entering the labor market. And there are many more young people to come. In sub-Saharan Africa alone, the population aged 15–24 will likely increase from its current level of 170 million to 360 million by mid-century. With youth unemployment rates already high, assuring proper education and creating jobs for those hundreds of millions of young people are top priorities.

If not given the chance for a decent life, these masses of young people without much hope for the future can pose a serious threat to social and political stability. But if they are provided with education and appropriate jobs, the young possess enormous potential for innovation, including the ability to adopt new technologies that accelerate economic progress and speed up the transition to a green economy. With a long life ahead of them, young people are likely to have genuine interest in sustainability because they themselves would experience the repercussions of unsustainable trends.

Ages 15–24 are when people marry and begin to have children. Increasing education and employment will have a predictably major impact on fertility decline through postponed marriage and childbearing, thereby reducing future population growth in the developing world. Hence, ensuring appropriate investment in young people—which must begin in early childhood when the seeds of future development are planted—must be an essential component of broader policy packages to promote global sustainable development.

## Differential vulnerability of people must shape appropriate policy

Environmental degradation and climate change do not affect all countries and all geographic regions in the same way. Vulnerability also varies significantly among people living in the same region, according to their socioeconomic circumstances. Even within a household, effects can differ importantly according to age and gender. Policies to reduce vulnerability must therefore focus on the most vulnerable segments of the population within countries and regions. Region-specific or even urban/rural-specific policies alone no longer suffice. Ignoring the more particular demographic dimensions of vulnerability will misdirect the focus of policy and dilute its impacts.

The spatial distribution of populations among regions, between village and city, and across cities is a significant dimension of sustainable development. Migration within and between countries has always been an integral part of the human response to changing economic, social, and environmental conditions. This pattern is likely to continue, not only due to increased economic opportunities facilitated by improved information and transport systems and globalization of production and labor markets, but also exacerbated by population displacement and relocation due to environmental degradation and civil conflict.

The principal demographic factors that increase vulnerability are poverty, poor health, low levels of education, gender inequality, declining family support for the elderly, and unfavorable geographic location. Populations with these characteristics also often lack a political voice, putting them at even greater risk. Within these populations, women and children are usually the poorest and least empowered. Vulnerability is reduced and adaptive capacity enhanced where there is investment in poor people's human capital, particularly their education, and most particularly the education of girls and women, whose importance in these adoptive and adaptive processes is now known to be especially great. Policies that do not include features focused on these people will likely not succeed.


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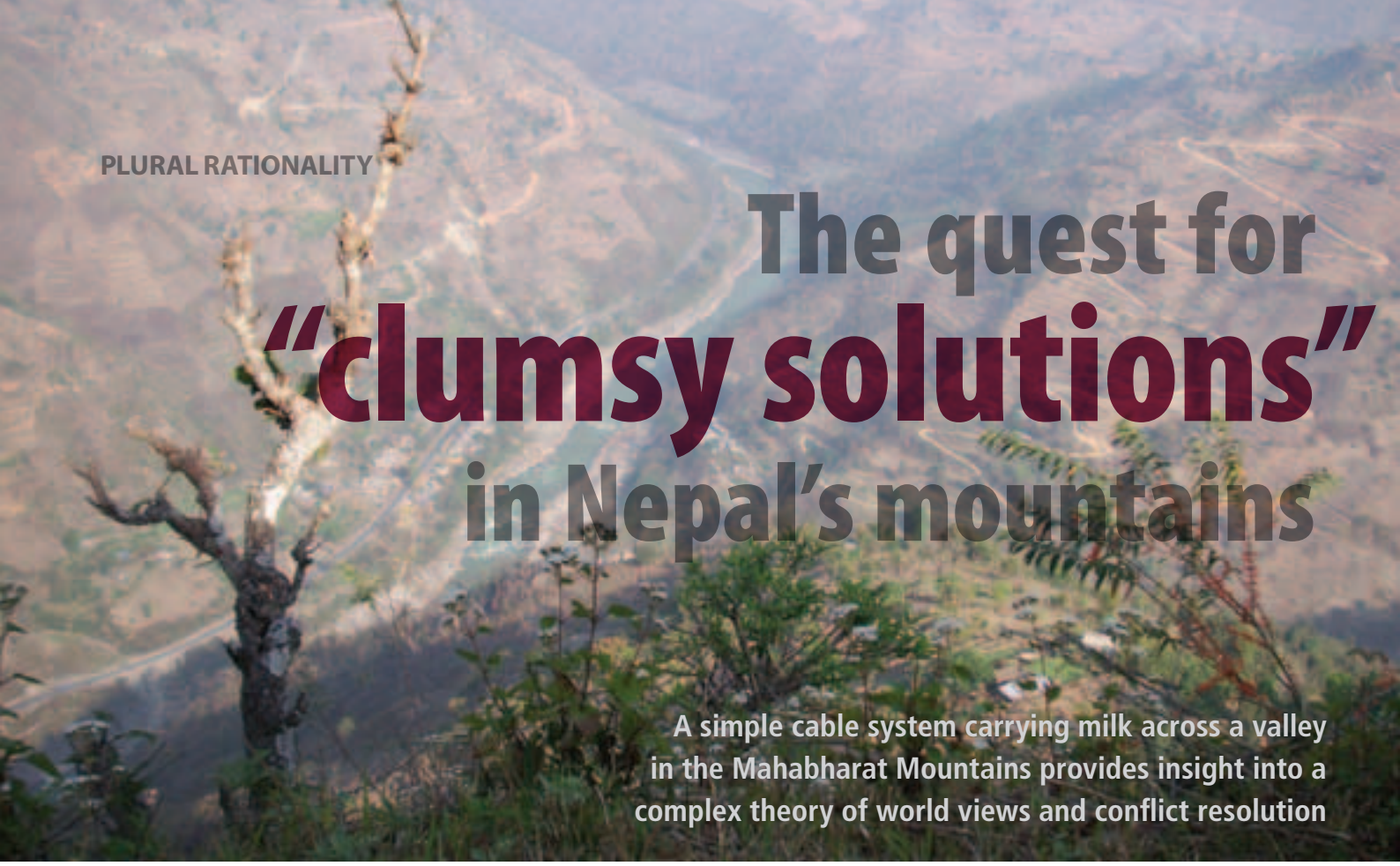
## Five action implications for sustainable development

- Recognize that the numbers, characteristics, and behaviors of people are at the heart of sustainable development challenges and of their solutions.
- Identify subpopulations that contribute most to environmental degradation and those that are most vulnerable to its consequences. In poor countries especially, these subpopulations are readily identifiable according to age, gender, level of education, place of residence, and standard of living.
- Devise sustainable development policies to treat these subpopulations differently and appropriately, according to their demographic and behavioral characteristics.
- Facilitate the inevitable trend of increasing urbanization in ways that ensure that environmental hazards and vulnerabilities are under control.
- Invest in human capital—people's education and health, including reproductive health—to slow population growth, accelerate the transition to green technologies, and improve people's adaptive capacity to environmental change. ■



PLURAL RATIONALITY

# The quest for "clumsy solutions" in Nepal's mountains

**A simple cable system carrying milk across a valley in the Mahabharat Mountains provides insight into a complex theory of world views and conflict resolution**

Every morning, high on the mountainous rim of Nepal's Kathmandu Valley, a secondhand Austrian cable system moves metal carriers containing fresh milk across a deep valley to a truck waiting on the nearest road. Given the rugged topography, this two-mile link is a simple, cheap, and efficient way of getting milk to market in the capital city before it spoils.

When IIASA anthropologist Michael Thompson first heard of this cable system, known as the Bhattedanda Milkway, it was just a curiosity—an interesting solution to a problem. But when he heard of its conflict-ridden history while attending an IIASA workshop in Kathmandu, he realized that it provided an excellent illustration of his work on the theory of plural rationality (also called Cultural Theory). "A concept without an example," he says, "is difficult to get across."

The story of the Bhattedanda Milkway forms one of the eight case study chapters in a new book he is writing with 14 Nepali colleagues, ranging from former government ministers and senior civil servants to hydro-entrepreneurs and manufacturers of electric vehicles. The book—"Development, Climate Change and Clumsiness: The Lessons From Nepal"—examines the implications of the plural rationality concept for solving problems, be it villagers trying to get milk to market or nations endeavoring to limit greenhouse gas emissions.

## PLURAL RATIONALITY

The theory, developed originally by anthropologist Mary Douglas and expanded by Thompson and his colleagues, argues that there are just four ways of organizing, perceiving, and justifying social relations: *hierarchy*, *individualism*, *egalitarianism*, and *fatalism*. These four "ways of life" conflict in every conceivable social domain because each will define both the problem and the solution in a way that contradicts the others. There are, in consequence, four "voices."

- The hierarchist voice is pro-control. It talks of "global stewardship," is quick to point out that what is rational for the parts may be disastrous for the whole, and insists that global problems such as climate change demand global and expertly planned solutions.
- The individualist voice is pro-market. It calls for deregulation, for the freedom to innovate and take risks, and for the internalization of environmental costs so as to "get the prices right."
- The egalitarian voice is strident and critical. It scorns the idea of "trickle down," argues for zero-growth and calls for major shifts in our behavior so as to bring our profligate consumption down within the limits set by Mother Nature.
- Fatalist actors see no possibility of effecting change for the better, and tend to have no voice. Even so, they have their vital part to play because we need to hear their counsel to not waste time and money over things about which we can do nothing.

Development aid, Thompson observes, being framed largely from the hierarchical standpoint, has always been "elegant." That, in his view, is not a compliment because elegant solutions entail the silencing of all but one of the four voices. Instead, he values "clumsy" solutions: initially invisible options that emerge from the messy and argumentative process in which each voice is able to make itself heard and is also responsive to the others.

Which brings him to the Bhattedanda Milkway story.

## CONSTRUCTIVE CONFLICTS

Before the milkway was built, villagers had no option but to boil their milk down into *khuwa*, a longer-lasting, but less valuable, condensed milk. With the advent of the milkway, the five-hour trek hauling *khuwa* down into the valley and up to the road, has been reduced to a 20-minute transport. The economic benefits, once the ropeway opened in 1995, were immediate, with villagers' incomes increasing by at least 30 percent. But other effects were equally important.

- The villagers no longer had to spend hours each day collecting firewood or sitting in front of a hearth boiling milk. "Household members," Madhukar Upadhya, the author of the Bhattedanda case study, writes, "especially the women and children, had to inhale the smoke while *khuwa* was being made. Now the indoor air is much cleaner."

The rugged Mahabharat Mountains in Nepal make moving goods to urban markets very difficult. The Bhattedanda Milkway (*below*) has enabled villagers to move milk and other produce more efficiently, resulting in an economic boom for the farmers.

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- Once *khuwa* processing stopped, so did the cutting of the 400 tons per year of firewood needed to boil down the milk. With young plants and saplings no longer being trampled by firewood collectors, the health of the forest is much improved and biodiversity loss has been reversed.
- In addition, Upadhya notes, "farmers realized that they could export perishable farm produce to market … and have now diversified into tomatoes, green vegetables, and beans." And with increased income has come better healthcare, schooling for the village children, and corrugated iron rather than thatched roofs on their houses.
- Finally, thanks to the increased revenue, the village milkway committee is now able to provide loans to local merchants at interest rates far below those charged by the banks and the moneylenders. "The ropeway," Upadhya writes, "has thus become not only a transport system but a community-wide benefit provider, thanks to the social capital it has itself generated."

As obvious as these benefits may seem, constructing, maintaining, and managing the milkway was not a straightforward process.

In 1985 when the Nepali government, with the European Union as the aid donor, initiated a "watershed project" in the area to lessen the likelihood of landslides and floods, poverty-alleviation was not on the agenda. Five years later, the Nepal Water Conservation Foundation, as part of an assessment of the project, raised the question of what kind of aid could actually help the local people. Only then, when it emerged that the cycle of poverty was tied to the making of *khuwa*, was a diesel-powered ropeway proposed. The idea was not well received.

The ropeway, officials objected, was not part of the authorized watershed project and would be more expensive than planting trees and stabilizing landslides. Beyond that, there was no local expertise to build and operate a ropeway, the Ministry of Forests did not fund transportation projects, and community mobilization was irrelevant because, as Upadhya notes, the whole ropeway idea was "unheard of." The objections, Thompson points out, reflected the hierarchical view; the individualist and egalitarian voices were silenced. But in 1990, as democracy was restored and a 30-year ban on political parties lifted, the Nepali government and its foreign donors were no longer able to set the development agenda. With other voices able to make themselves heard in the new political context, the ropeway suddenly gained favor and began operating in 1995.

Its rapid economic success raised new concerns. Some worried that funding for road construction would be reduced, and political leaders who had not been involved in the project, and thus could not take the credit for it, began to push for the reinstatement of an old and unusable road as a better alternative. In Bhattedanda itself, squabbles within the milkway management committee eroded its democratic basis and, once the road was repaired, the cable system was shut down. Hierarchy held sway once more.

A few years later, heavy rains washed away the new road and the export of fresh milk came to an abrupt halt. The villagers were suddenly back in their cycle of poverty, boiling down milk into *khuwa*. They responded by resolving their political differences, reopening the milkway and setting up a new management system. In the process, they converted the power source from imported diesel to local hydroelectricity, making the operation more environmentally friendly and much cheaper.

## WHO BENEFITS?

The Bhattedanda Milkway provides a good demonstration of a counter-intuitive feature of clumsy solutions: that they enable each set of actors to get more of what they want, and less of what they don't want, than they would have received if they had silenced the other voices and imposed their own elegant solution.

- However you choose to measure it, the milkway is economic growth—development as defined in the conventional "aid paradigm"—achieved, moreover, by means of a carefully planned intervention that would never have happened "autonomously." So those speaking with the hierarchical voice have certainly achieved much of what they wanted.
- Individualistic actors—the farmers, with their incomes immediately increased by 30 percent, have also come out well, especially when you take into account the host of innovations that have shifted them away from subsistence agriculture into what is an increasingly lucrative form of market gardening.
- And those who speak with the egalitarian voice have secured the conservation of the forest, along with a convincing demonstration of how to effect the transition from fossil fuels to renewables. Moreover, it is the "poorest of the poor" who have benefited most.

And because of the milkway's success, the ropeway is being extended to even more remote and impoverished villages. ■

**Further information** Thompson M, Warburton M, Hatley T (2007). *Uncertainty: On a Himalayan Scale*. Himal Books, Patan Dhoka, Lalitpur, Nepal.

**Dr. Michael Thompson** is an anthropologist and Senior Research Scholar with IIASA's Risk, Policy and Vulnerability Program. He has written several books and numerous articles on Cultural Theory.

POPULATION

# Education spells hope for world wellbeing

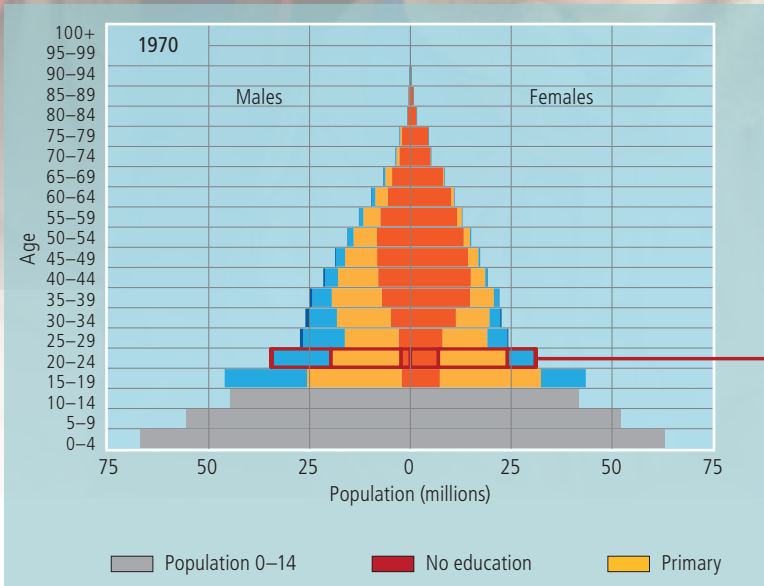
**Education has a positive effect on every aspect of human health, wealth, and wellbeing. Educational attainment, the evidence now clearly shows, is linked to economic growth as well as fertility and life expectancy. Even the transition of societies into modern democracies is rooted in widening educational participation among the young. But strong further investment in education in the developing world is needed if the potential benefits of education are to be realized.**

Photo © Lee Snider | Dreamstime.com

In a time of economic crises, increasing food insecurity, continued rapid population growth in poor countries, and the growing prospect of adverse consequences from climate change, the future looks rather bleak to many people. Nevertheless there is still cause for optimism, argues IIASA's Professor Wolfgang Lutz. Recent research on education trends around the world points to significant future improvements in human capital and, as a consequence, better health and material wellbeing worldwide.

The link between education and economic growth is now well established (see Box: Proving the case). The wider significance of education is perhaps less well understood. Almost universally, for example, more highly educated people have better health and live longer. Studies further show that the education of women makes a striking difference to family size, their own health, and that of their children. More educated women typically want fewer children, find better access to contraception, and are better able to overcome obstacles to family planning, such as the objection of their partner or misinformation.

Universal secondary female education could, as the story of Mauritius shows, lower population growth and break the vicious circle of poverty and high population growth. During the 1950s Mauritius experienced population growth rates of more than 3 percent a year. Following a strong but strictly voluntary family planning program launched by the government during the 1960s, the total fertility rate fell from more than 6 to less than 3, one of the world's most impressive fertility declines.




## PROVING THE CASE: EDUCATION AND ECONOMIC GROWTH

Using new demographic techniques, IIASA researchers are now able to show that education has a clear positive effect on economic growth. Why had previous evidence for this link been ambiguous? "This was due to using education data without the necessary age detail," says IIASA's Professor Wolfgang Lutz. "Previous data considered the entire adult population aged 25 years and older as one age group. Therefore rapid improvements in the education of the young adult population—an important driver of economic growth—did not produce enough statistical signals in a very broad age group, which also includes elderly, poorly educated people."

To address this shortcoming, IIASA has developed *demographic multi-state modeling*—an approach that provides age- and sex-specific reconstruction and projection of human capital in a unified framework that also takes account of educational mortality and fertility differentials. Studies of this new data by five-year age groups for 120 countries since 1970 show conclusively

The reason for this success, researchers believe, is that by 1962 more than 80 percent of all young women could read and write: a factor that increased access to family planning. Subsequently Mauritius experienced the benefit of the so-called demographic bonus through a decline in youth dependency combined with still very low old age dependency, resulting in a period of economic growth, investments in infrastructure, and further education.

In Ethiopia women without education have on average 6 children, whereas those with a least junior secondary education have only 2. "It's fair to say that progress in female education together with access to family planning services are the key determinants of future population growth in less developed countries," Professor Lutz points out. "For the world as a whole, more education could result in about 1 billion fewer people by 2050."

Exploring the impact of maternal education on child mortality in developing countries, a recent study concludes that in the vast majority of countries, maternal education matters more for infant survival than household wealth. The study further highlights some overwhelming evidence for a link between maternal education and child health. Such findings suggest a reorientation of global health policies to more directly address female education as a primary policy option for improving child health.

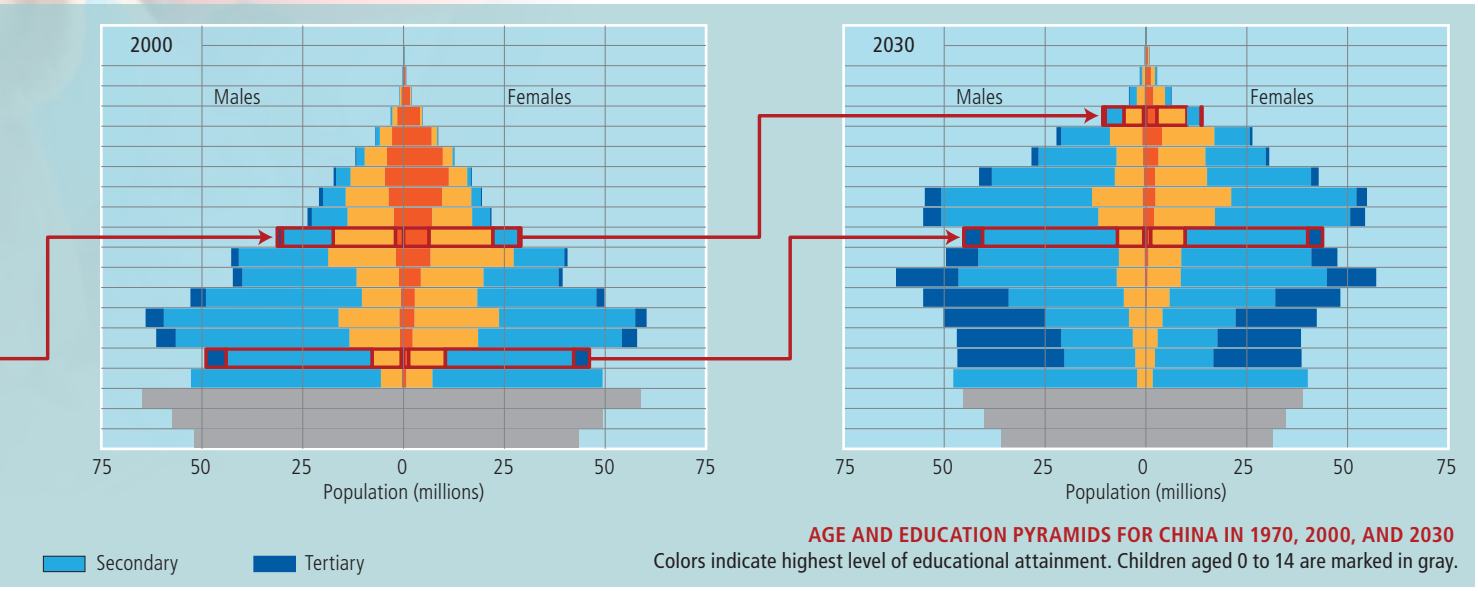
Yet education, IIASA researchers suggest, holds even wider potential to tackle some of the world's ills. "A radical focus on education also qualifies as a key strategy in our quest for sustainable development," argues Professor Lutz. "Better educated people will be better empowered to adapt to the consequences of already unavoidable climate change. Studies on past natural disasters show that—after controlling for income—education reduces vulnerability and greatly enhances the capacity for recovery. In this sense, investments in education are likely to be the best long-term investments to enhance adaptive capacity."

In terms of the emergence and sustainability of democratic political institutions, education has been shown to play a part. Recent research supports the view that as people become more educated they also become more politically aware and more inclined to participate in the political process. Unprecedented increases in education levels, particularly among females—as have taken place recently in Iran—could, researchers suggest, quicken a country's move toward a more democratic political system.

"Interestingly, female education appears to matter more than male when it comes to the effects of education on governance and on the transition to free democracies," Professor Lutz points out. "Obviously, women play a key role when it comes to exerting the checks and balances on those in power that are necessary for a free democracy to emerge."

Given the wealth of current evidence suggesting an impact from education that extends from fertility right through to freedom, the time may be ripe for a radical reorientation of global development priorities. "Of course the benefits of education come with a time lag: for example, when more girls enter elementary school, it will still take some 20 years or more until they can make the difference as more empowered young women," Professor Lutz states.

In this sense, education efforts are a longer-term investment with significant near-term costs, he continues. But in times of confusion regarding the *right* global development policies (and the fact that the forthcoming Rio+20 Conference lacks a clear paradigm about how humanity needs to go forward), the proposal of a radical focus on enhancing human capital growth through universal education and basic health could prove a promising strategy. ■




**AGE AND EDUCATION PYRAMIDS FOR CHINA IN 1970, 2000, AND 2030**
Colors indicate highest level of educational attainment. Children aged 0 to 14 are marked in gray.

that educational attainment is indeed the key driver of economic growth.

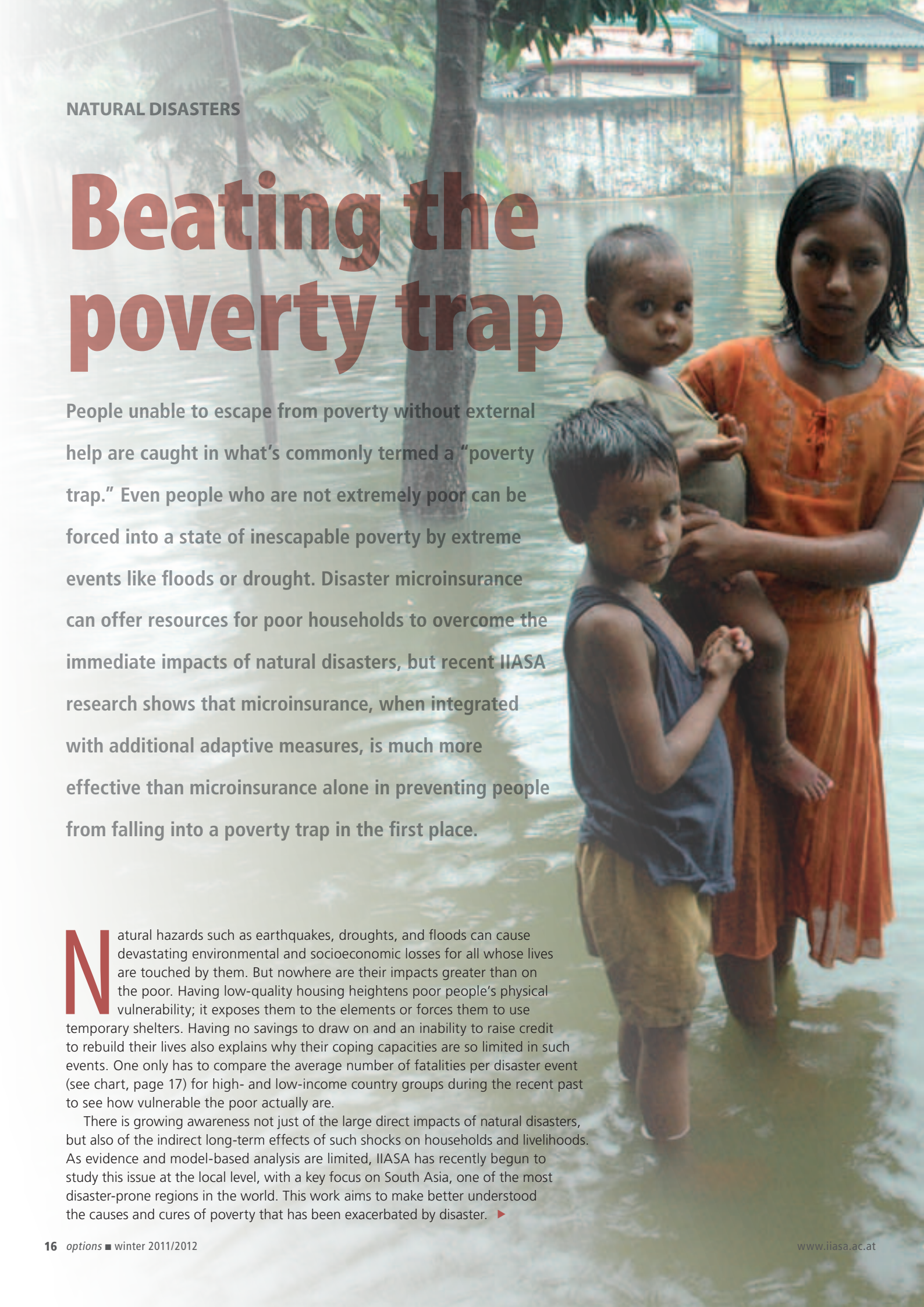
How do multi-state methods work? As the figure above shows, applying multi-state methods for projecting backwards (reconstruction) or forwards (into the future) requires that at least one data point be available for the size and structure of the population by age, sex, and level of educational attainment. Using the example of China, the analysis presented in the figure begins with the age and education pyramid for 2000. From that point it is relatively straightforward to reconstruct the educational structure for 1970 as well as forecast forwards to 2030.

China is not only the world's most populous country but has also experienced one of the most rapid fertility declines together with a phenomenal education expansion. Interestingly, as the figure illustrates, much of the future improvement in the educational attainment of China's adult population is already embedded in today's education structure. ■

**Further information** Lutz W, KC S (2011). Global Human Capital: Integrating Education and Population. *Science* 333(6042):587–592 [doi:10.1126/science.1206964].

**Professor Wolfgang Lutz** is the Leader of IIASA's World Population Program and Founding Director of the Wittgenstein Centre for Demography and Global Human Capital.

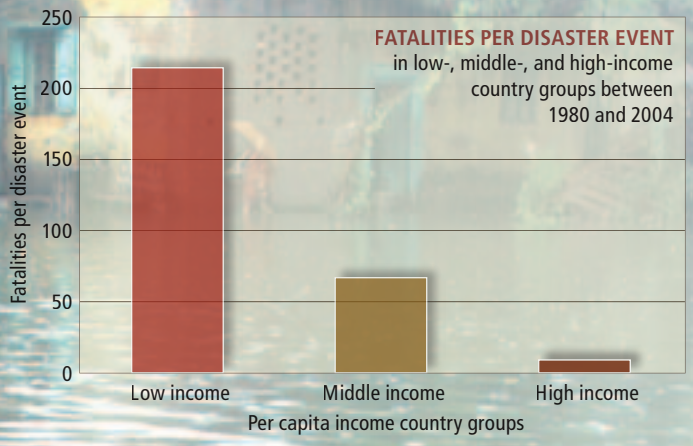
# Beating the poverty trap

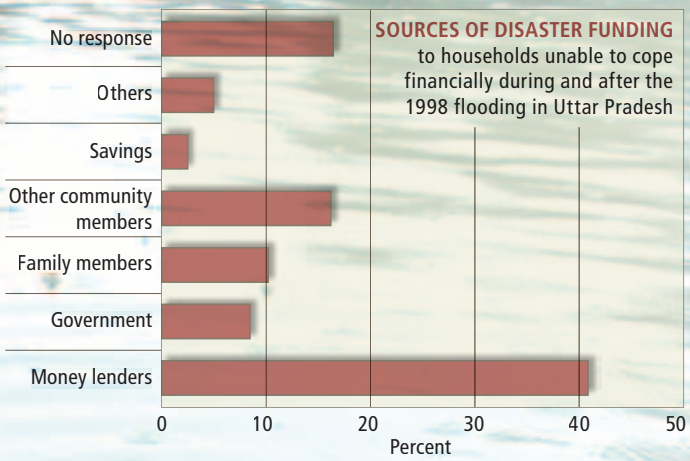


**People unable to escape from poverty without external help are caught in what's commonly termed a "poverty trap." Even people who are not extremely poor can be forced into a state of inescapable poverty by extreme events like floods or drought. Disaster microinsurance can offer resources for poor households to overcome the immediate impacts of natural disasters, but recent IIASA research shows that microinsurance, when integrated with additional adaptive measures, is much more effective than microinsurance alone in preventing people from falling into a poverty trap in the first place.**

Natural hazards such as earthquakes, droughts, and floods can cause devastating environmental and socioeconomic losses for all whose lives are touched by them. But nowhere are their impacts greater than on the poor. Having low-quality housing heightens poor people's physical vulnerability; it exposes them to the elements or forces them to use temporary shelters. Having no savings to draw on and an inability to raise credit to rebuild their lives also explains why their coping capacities are so limited in such events. One only has to compare the average number of fatalities per disaster event (see chart, page 17) for high- and low-income country groups during the recent past to see how vulnerable the poor actually are.

There is growing awareness not just of the large direct impacts of natural disasters, but also of the indirect long-term effects of such shocks on households and livelihoods. As evidence and model-based analysis are limited, IIASA has recently begun to study this issue at the local level, with a key focus on South Asia, one of the most disaster-prone regions in the world. This work aims to make better understood the causes and cures of poverty that has been exacerbated by disaster. ▸




## DISASTER IMPACTS IN INDIA AND BANGLADESH

IIASA researchers and collaborators have recently surveyed more than 320 households in Uttar Pradesh, India. This is one of the largest and poorest states in India, and faces a multitude of climate hazards. Among the households surveyed, 53 percent were living below the poverty line as defined by the Indian government, while 69 percent of households had a least one outstanding loan and a quarter of households had no savings. During the 1998 flood in Uttar Pradesh, losses affecting all income groups (very poor, poor, middle-income, and rich) totalled 43 percent of total annual household income, but the very poor experienced losses of more than 70 percent. Household income provides the initial and obvious source of money to rebuild lives after a disaster event, but of all the households affected by flood, 73 percent reported that this was not enough to allow them to cope.

Another IIASA study investigated the riverine islands (chars) of north-western Bangladesh, home to the poorest and most vulnerable communities in the country with over 80 percent living in extreme poverty. The chars are exposed to frequent flooding. Says Reinhard Mechler, one of the study's authors: "A key driver and consequence of poverty here is inadequate and disaster-prone housing, coupled with a lack of means for rebuilding safer homes. Flooding also creates further negative impacts. For instance, there is a close correlation between flooding and the incidence of water-borne diseases like diarrhea and dysentery."

Sources of funding during and after disasters in such contexts are generally very limited, with households in Uttar Pradesh turning to moneylenders, the community, or family members for financial help (see chart above). Very few have savings and, while 15 percent of those surveyed had some kind of insurance, primarily life insurance, nearly all respondents were unaware of any insurance schemes to cover disaster losses. IIASA's Dr. Stefan Hochrainer-Stigler, another author of the study comments: "Borrowing is one of the most important options poor people have for recovery, but owing money can seriously affect people's future coping capacity and potentially lead them into a poverty trap."

The Cancun Adaptation Framework, established by the 2010 UN Climate Change Conference highlighted the pressing need to find ways to help the world's most vulnerable people face the inevitable consequences of climate change—including weather shocks. Preparations for Rio+20, the United Nations Conference on Sustainable Development, emphasize "natural disasters and the ability to prepare for and recover from them" and "increased resilience at the national and global level" as two of the most important global emerging challenges.

## THE DISASTER–MICROINSURANCE CONUNDRUM

Interest continues to grow in disaster microinsurance as a means of providing the necessary resources for households to overcome natural disasters. Particularly in South Asia, creative alliances among NGO/community groups, microfinance organizations, rural development banks, government regulators, entrepreneurs, and international financial and donor institutions have been pioneering options such as microfinance and disaster microinsurance products targeted directly at the poor.

A recent joint report by IIASA and the All India Disaster Management Institute carried out the first large empirical cross-country assessment of the impact of disaster microinsurance in South Asia. Based on a survey of more than 2,000 insured and non-insured householders, researchers assessed the impact of microinsurance products on disaster-prone communities. Among many results, the study found that insured households were more likely to be better prepared for disasters—for instance, insured families reinforced their homes to help them withstand future shocks—than households without insurance. Yet, interestingly, this empirical study did not find significant improvements in individual welfare—measured through levels of savings and debt over the last few years—for households with insurance compared to those without. Why is this?

The lack of increased wellbeing for those with insurance shows the importance of considering a more comprehensive adaptation package. A recent model-based analysis of the costs and benefits of adaptation in Uttar Pradesh suggests that the highest societal benefits are achieved through an integrated strategy combining microinsurance with physical adaptation measures. As Dr. Hochrainer-Stigler explains: "Our findings suggest that in Uttar Pradesh the most effective way of coping with drought is both by irrigating the fields to reduce the risks from commonly occurring, less-serious droughts and purchasing micro-insurance to cover losses from rare but catastrophic droughts."

Thus, according to IIASA research, although disaster microinsurance can provide resources to offset immediate needs in disasters, it needs to be coupled with other risk reduction options to help ensure that disasters affect the poor less in the long term. More work combining empirical with model-based assessments is under way to provide further insights into and options for tackling disaster-induced poverty traps and preventing more families from falling into them. ■

**Further information** A list of sources can be found online at www.iiasa.ac.at/Options/sources.

**Dr. Stefan Hochrainer-Stigler** and **Dr. Georg Pflug** are Research Scholars and **Dr. Reinhard Mechler** leads the research group "Disasters and Development" in IIASA's Risk, Policy, and Vulnerability Program.

Photo © Samrat35 | Dreamstime.com

# The role of human behavioral games in international negotiations

**Karl Sigmund, an IIASA mathematician, works in a world of games. He began his career studying dynamical systems, and then population dynamics and cooperation among early humans. He now applies his lessons learned from those first hunter–gatherers to countries and international organizations.**

Karl Sigmund's games are serious and sometimes dark, investigating whether revenge-based retaliation against defectors, exploiters, and free riders by peers in a group is superior to retribution delivered by impersonal institutions. The games also have a more positive aspect, offering rewards for trusting and cooperating with the other players. With the right mixture of positive and negative incentives, players are encouraged to seek success through cooperation instead of trying to get ahead through exploitation and free riding.

Sigmund began using these "public goods games" early in his career to study the first instances of cooperation in human societies, including those of hunter–gatherers who lived tens of thousands of years ago, before institutions and laws existed to dictate behavior.

The lessons learned from years of behavioral games research have led Sigmund to his current work, which examines how to regulate the selfish actions of individuals that jeopardize common goods, such as clean air, civil security, fish and game stocks, or even the global climate. In a limited world, Sigmund says that "open-access resources that are utilized unrestrictedly tend to suffer from overexploitation [and] will often collapse through an inevitable Tragedy of the Commons."

One goal of the current project, being conducted in IIASA's Evolution and Ecology Program, is to explore how top-down regulations can be improved by integrative assessment of the conflicts of stakeholders and by scaling up the successful characteristics of self-organized bottom-up governance.

Sigmund explains that regulations to prevent the abuse of resources can emerge bottom-up, through agreements among stakeholders, or be imposed top-down, through the involvement of governing agencies. Bottom-up regulations are "often not only remarkably efficient," the project synopsis says, but "tend to be perceived by the involved stakeholders as equitable and fair."

Top-down regulations, in contrast, have been marred by a history of fiascoes. Regulations can fail for a host of reasons, the synopsis notes, including "when they are based on insufficient analyses of underlying systems dynamics, when stakeholder interests are misconstrued, when side effects and loopholes of seemingly appropriate incentives are overlooked, when they disagree with established social norms, and when governance structures are inadequate."

"I'm familiar with the bottom-up, and now I want to check if those characteristics apply to negotiations between institutions or between nations," Sigmund says. "All of the complex climate treaties are examples of the public goods game where the players are nations instead of individuals. They start with a very complex procedure of first signing a treaty, but the treaty has to be ratified in every country, and only when it is ratified can it be implemented."

Treaties typically contain incentives and penalties for the signatories, but none of these can be implemented until the ratification process is concluded. Reaching an agreement, then implementing a system of rewards and punishments, is a "principle that works very well when small groups of individuals are collaborating," Sigmund says, "but it seems quite difficult to do this with nation states, particularly when large numbers of nation states are trying to work together."

One of the lessons of small-group behavior, he says, is that "punishing others is a costly thing, so there is the temptation to let others, such as neighbors, punish the exploiters in the group. If I can just free ride on someone else doing the punishment, then cooperation could be maintained without any cost to me."

The issue of free riding quickly becomes complicated because a free rider is an exploiter who is not contributing to the group. If free riding is allowed, the group can collapse, so free riders should be punished to boost the interests of the group. But a group member who stands back while someone else bears the risk and cost of punishing

an exploiter is, by definition, a free rider deserving of punishment.

"There is a strong incentive to free ride on the propensity of others to punish those who free ride," Sigmund says. "This is called second-order free riding."

On the larger scale of his current research, Sigmund is seeing the free-riding pattern in interactions between nations. "The most glaring example is the euro," he says, "which seems to be a good idea in principle, but there is the possibility of exploiting the efforts of others, so some nations can free-ride on the contributions of other nations."

According to Sigmund, some states will eventually have to reach the point of punishing others, according to patterns observed in small-group games. "You don't want war, but how to coerce nations by other means is an extremely fascinating problem," he says.

Sigmund notes that he studies these interactions from a "biology and evolution of the human species" aspect, while economists and legal professionals approach them from an inter-state negotiations point of view. "I hope we are converging on some joint results," he says.

In a complex arena in which players, be they individuals or states, can be characterized by their propensities instead of predictably rational behaviors, a new phenomenon has been discovered in the past two years that adds another layer of intrigue to the public goods game.

"In recent experiments it's been found that in some cultures you find punishments that, themselves, are anti-social, meaning that the good guys are getting punished," Sigmund says. "It seems very strange and was discovered only recently because the first experiments on punishment in public good games were done 10 to 15 years ago in Switzerland and the East Coast of the United States, and in those places you don't find a propensity for anti-social punishing."

But when the same experiments were conducted in some regions of Russia and Eastern Europe, he says, researchers found a significant amount of punishment aimed at the "good guys."

"There is a connection between how individuals behave in small groups in these experiments and how strong the rule of law is in the state where the individual is living," he says. "The United Nations has an index yearly measuring the rule of law in every country, and it is in countries where that index is low that you find the anti-social behavior in game playing."

The reasons why the good guys get punished isn't clear, but Sigmund suspects it is tied to some basic, and dark, human behavior. "It may have to do with the idea that, 'they had it coming,'" he says. "One hates to have someone who is so much better than you in a group, so maybe the anti-social punishers anticipate that eventually they will be punished by the good guys for exploiting the group, so they begin by punishing the good guy."

The anti-social behavior is evident in small groups, but those small groups are embedded in a larger culture, and the negative behavior seems to be culture-specific. In a public goods game, Sigmund says, people who contribute and cooperate eventually earn money and come out ahead. In cultures with the anti-social behavior, some don't engage in such mutually beneficial behavior and will instead start punishing the good guys and retaliating to such a degree that the whole game is destroyed.

"It is fascinating how this microeconomics game reflects on macroeconomics," he says. "You can do this simple experiment involving a handful of players and say something about the state of the national economy for that country."

What Sigmund says he hopes for with his work are insights that enable communities to pursue solutions that fit their specific situations. ■

**Further information**
www.iiasa.ac.at/Research/EEP

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# Poverty alleviation is about people

**New IIASA research aims to discover more about the people on the receiving end of our current aspirations to expand energy access.**

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In his foreword to "Energy for a Sustainable Future," the report of his Advisory Group on Energy and Climate Change (AGECC), UN Secretary-General Ban Ki-moon wrote: "Expanding access to affordable, clean energy is critical for realizing the MDGs and enabling sustainable development across much of the globe."

This is a noble goal, expressed by many world leaders. But how does one accurately judge whether any progress is being made toward expanding access to energy or, for that matter, enabling sustainable global development? Neither sustainability nor energy poverty can be easily boiled down to one number. Tracing changes in energy poverty levels back to specific past efforts is extremely challenging because general economic growth, social and infrastructural development, and a variety of environmental and human behavioral factors can influence energy access. Equally, data are lacking in crucial areas. What factors drive households to escape from energy poverty? And what are the risks and vulnerabilities they face that cause them to fall back? Such research is very data-intensive and requires panel studies that track the same group of households over long periods of time.

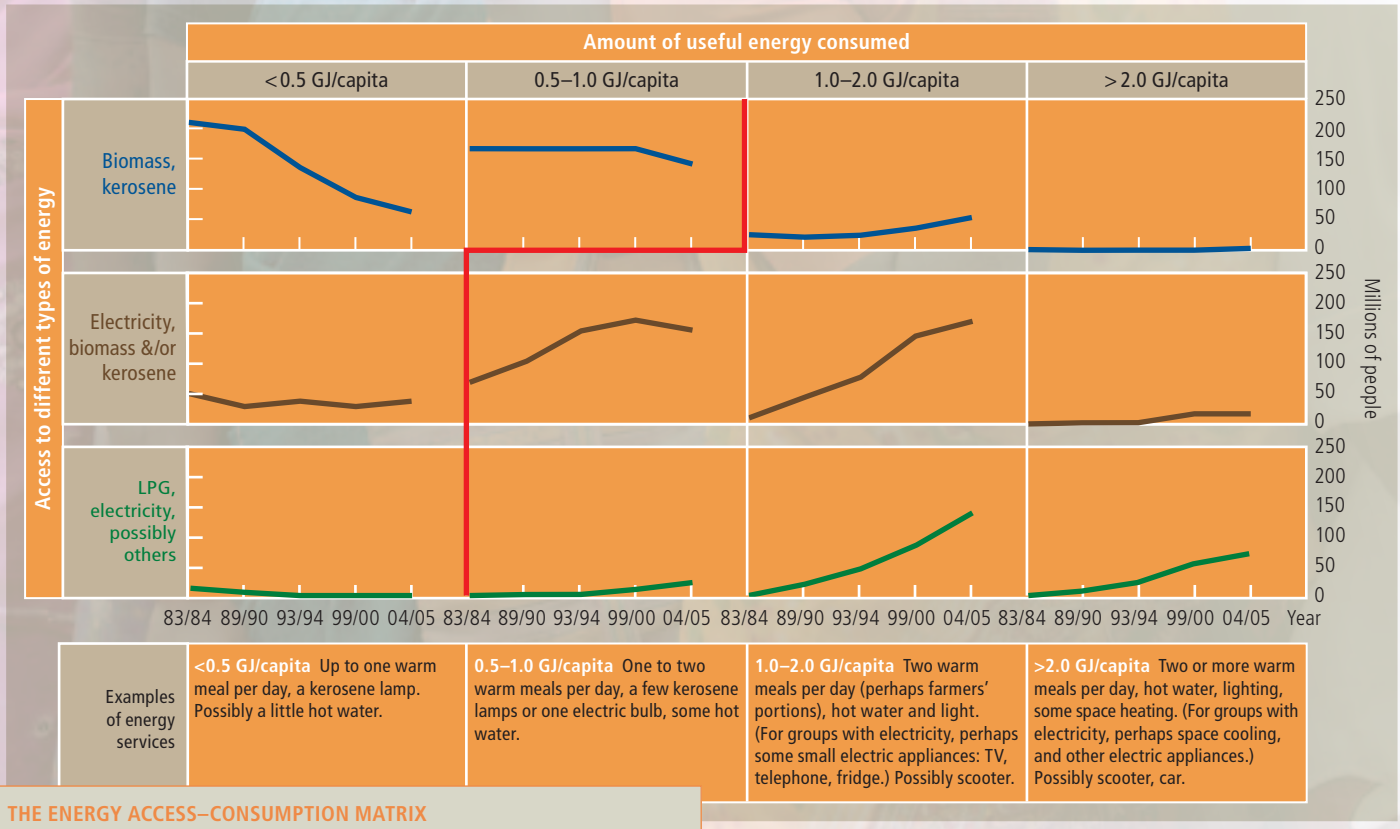
Many studies have tried to draw up indicators so that comparisons can be made of how well projects, programs, and policies aiming for sustainable development have worked—for instance, by using energy indicators to provide an impartial yardstick for poverty assessments or by suggesting a lower limit to energy use of around 2,000 W per capita for a decent standard of living—but no set of indicators suitable for all purposes has ever been up to the task of providing the timely and comprehensive knowledge we need if we are to achieve the MDGs and development goals beyond.

Energy poverty is caused by a complex combination of factors, including lack of physical availability of certain energy types, low income, and the high costs associated with using energy. But knowing not just *who* is energy poor, but *how* and *why*, is essential for designing effective programs and policies too. For this, detailed disaggregated, regularly produced data are needed, able to show shifts in the composition of energy poverty over time so that progress, or lack of it, can be monitored. In many developing countries, the kind of detailed data required for carrying out such in-depth analysis are not available.

An attempt to identify and fill some gaps in our knowledge about energy poverty is ongoing at IIASA. We have developed an energy access–consumption matrix (*right*) to describe the entire population distribution of a nation in terms of their level of access to different kinds of final energy and the amounts they consume in useful energy terms. We continually refine and update the matrix to cross-reference new data on additional dimensions of poverty, for example, % literate, % living in rural areas, % with access to tap water, average per capita land holding, average per capita expenditure, etc. In the matrix, an approximate threshold can be defined, both in terms of the level of access and quantity consumed, to distinguish the energy poor from the non-poor (such as by the red line in the matrix). The matrix does not measure energy poverty per se, but it does provide a good basis for undertaking a comparison over time and thus assessing how the distribution of the population is shifting both in

terms of access and consumption levels. Below is an example of the energy access–consumption matrix applied to assess the situation for the last two decades for India.

We can glean new knowledge from this matrix. For instance, we see that between 1983–1984 and 2004–2005 in India the number of energy poor has declined but the inequalities in the distribution of population by energy access and consumption have grown. The number of people living in desperately energy poor households having access to only biomass and kerosene and using barely enough fuel to cook a full meal a day (top left cell) has decreased from 38 to 8 percent, while the number living in households having access to electricity and possibly also LPG, and using more than enough fuel to cook two full meals a day (four cells near bottom right of matrix), has increased from 3.5 to 42 percent.




**THE ENERGY ACCESS–CONSUMPTION MATRIX**
The matrix describes the entire population distribution of India in terms of their level of access to different kinds of final energy and the amounts they consume in useful energy terms. *Source*: Adapted from Pachauri & Spreng (2011).

We also found that differences in other dimensions of poverty for populations across distinct access levels are starker than those with varying amounts of consumption. Thus, between biomass and kerosene users in the highest and lowest energy groups there were few differences in terms of literacy and access to tap water. However, households using similar amounts of energy but having access to LPG and electricity also have greater access to tap water and higher literacy. Households using cooking fuels like dung or firewood as their primary source of cooking energy are also more likely to have a lower daily calorie intake on average than those that use more efficient and cleaner-combusting fuels such as kerosene or LPG.

These are just a few of the results obtained. But what we have found remarkable is just how understudied these end users have been in programs designed to improve energy access. For instance, much of the kerosene subsidized by the Indian Government for low-income households leaks to the black market and as rural households use kerosene for lighting rather than cooking, the subsidy is of negligible value in rural areas. A regular system of policy monitoring and regularly collected data for constructing indicators regarding kerosene usage could have helped inform policymakers and may have resulted in the design of a policy that better meets objectives.

Understanding the local context, the living conditions, as well as the physical state of the house in which a family is expected to adopt a new stove or fuel, is also crucial to the success of policies. What if, in cultures where women have no rights, the head of the household may not be inclined to introduce a new measure to ease the woman's toil?

The conclusions of much of our work point to the need for making monitoring and evaluation an integral part of all projects to generate the evidence needed to convince policymakers and donors of the positive impacts of household energy interventions—right from inception. And information also needs to be collected on the macro environment in which these households and communities operate, as local and national policies also impact the outcome of specific projects and interventions. Sustainability indicators are not worth much if they are simply aggregations and compilations of tons of statistics. Indicators are most useful when picked to measure a specific impact or aspect, often targeted to themes of special interest. Poverty alleviation is about people—people who are in situations very difficult for most of us to imagine.

Perhaps we should also remind ourselves that programs are there to benefit end users and that we do not know those end users intimately enough. ■

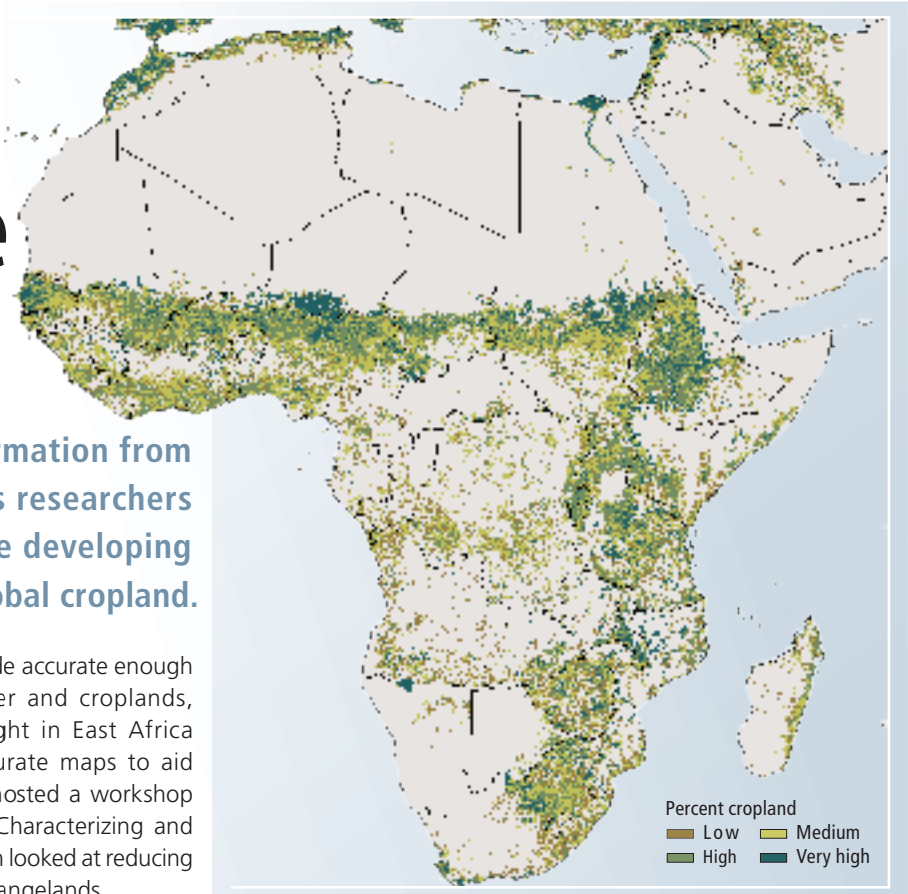
**Further information** Pachauri S, Sprenger D (2011). Measuring and monitoring energy poverty. *Energy Policy* 39(12) [doi:10.1016/j.enpol.2011.07.008].
▪ Pachauri S (2011). Reaching an international consensus on defining modern energy access. *Current Opinion in Environmental Sustainability* 3(4):235–240 [doi:10.1016/j.cosust.2011.07.005].

**Dr. Shonali Pachauri** is a Senior Research Scholar in IIASA's Energy Program.

AGRICULTURE

# Mapping out a more secure food future

**By bringing together information from multiple sources, IIASA's researchers and collaborators are developing more accurate maps of global cropland.**




**CROPLAND IN AFRICA** The hybrid map of cropland in Africa will be a living product that is continuously updated when new and better land cover information becomes available.

Existing mapping tools are failing to provide accurate enough information on the world's land cover and croplands, particularly in Africa. With the drought in East Africa highlighting the urgent need for accurate maps to aid agricultural decision making, IIASA co-hosted a workshop attended by over 70 international experts, "Characterizing and Validating Global Agricultural Land Cover," which looked at reducing inaccuracies in the mapping of croplands and rangelands.

Satellite imagery combined with ground-based data and spatial mapping tools can make an enormous difference to agricultural decision making from global to local levels. Accurate estimates of cropland are crucial to meeting the needs of the food security and land use modeling communities. Yet, existing global land cover tools fail even to provide consensus on the extent of cropland areas. One recent estimate puts the global area under cropland at between 1.22 and 1.71 billion hectares.

Encouraging developments, however, are on the horizon. These include the production of 30 million global land cover products by China and the USA, which are scheduled for release in December 2013, as well as the high-resolution spatial and temporal data that will be provided by the European Space Agency's Sentinel satellites at some point in the future. But as IIASA's Dr. Steffen Fritz points out: "While this progress is welcome, we need a solution that delivers more accurate cropland information in the short term."

This could be achieved, experts suggest, if the research and national map-making communities could be mobilized to share the data and products which already exist. "If national and regional products were to be made freely available, then an even more accurate cropland extent map could be developed for Africa and globally at minimal cost," Dr. Fritz explains.

Prior to the IIASA workshop which took place in June 2011, experts had contributed their own cropland maps and other geo-tagged data for use in the compilation of a new cropland extent map at a 1 km resolution to initiate the process of data sharing. At the workshop, international experts on remote sensing, land cover, land use, cropland and rangeland mapping, crop type mapping and area estimation discussed how to improve these maps, with an initial focus on African cropland.

IIASA researchers are currently leading a project to build this information into a "living," community-based consolidated cropland map for Africa. Using the products contributed by workshop participants, this map will be calibrated with national and subnational crop statistics. Validation will involve the wider community using crowd-sourced data from *agriculture.geo-wiki.org* and *Google Earth*. The first version of the map is expected to be published by the end of 2011 (download to be available from geo-wiki.org).

"This hybrid map will be a living product that will be continuously updated when new and better land cover information becomes available," explains IIASA's Linda See, co-organizer of the workshop. "The process of data sharing, which began with the workshop, should be seen as the start of a continuing process. The agricultural community is encouraged to take part by providing more national and regional data on croplands, both to help validate the product and to improve our current knowledge of how much cropland there is and where it is actually located." ■

**Further information** Characterizing and Validating Global Land Cover Workshop, IIASA 13–15 June 2011, Workshop Report. Available online at www.iiasa.ac.at/Research/FOR/lc/IIASAWorkshopReportJun2011.pdf.

**Dr. Steffen Fritz** and **Dr. Linda See** are Research Scholars in IIASA's Ecosystems Services and Management Program.

CLIMATE CHANGE

# Education: Key to climate change adaptation?

Formal education can positively influence people's capacity to cope with, and adapt to, adverse climatic conditions, says Dr. Christine Wamsler, a specialist in urban risk reduction and climate change adaptation at the Universities of Lund, Sweden, and Manchester, UK. "Greater attention should be paid to promoting improved access to formal education among those most at risk and to improving the quality of education."

Dr. Wamsler, an IIASA "YSSPer" in 2006, collaborated with IIASA's World Population Program in a study on education and climate change adaptation. "Our study explored the influence of formal education, as opposed to income, in determining the adaptive capacity of the residents of two low-income settlements in San Salvador (El Salvador) and Rio de Janeiro (Brazil) where climate-related disasters are prevalent," she explains. "We wanted to know how formal education influences people's level of risk, their coping strategies, and the institutional support they receive. We also wanted to identify the direct and secondary effects that education may have on disaster occurrence, and vice versa."

In both case study areas the research found that formal education had a direct effect on reducing risk as well as a mitigating effect on issues that increase risk. Formal education has a positive effect on, for example, people's level of awareness and understanding of existing risks, their access to information on potential risk reduction measures, their possibilities of getting a formal job, and their motivation to move out of a risk area. Formal education also has the potential to reduce underlying risk factors such as poor health, organized crime, corruption, teenage pregnancy, single motherhood, and informal settlement growth. It thus works positively against the stigmatization of slum dwellers, their exclusion from formal decision-making processes, insecure tenure, and inadequate housing and infrastructure.

"We also found that education plays a greater determining role for women than for men in terms of people's capacity to adapt," Dr. Wamsler states.

"Although further research is needed, promoting better access to formal education and improving its quality are justified as a way of increasing adaptive capacity," she concludes. "This is not just because formal education can increase income levels but also because natural disasters can negatively impact people's level of education and thus their adaptive capacity, resulting in a vicious circle of increasing risk." ■

**Further information** Wamsler C (2011). Climate Change, Adaptation and Formal Education: The Role of Schooling for Increasing Societies' Adaptive Capacities. IIASA Interim Report IR-11-024.

**Dr. Christine Wamsler** collaborated with IIASA's World Population Program on the above study.

ECONOMY

# Recession hits U.S. fertility

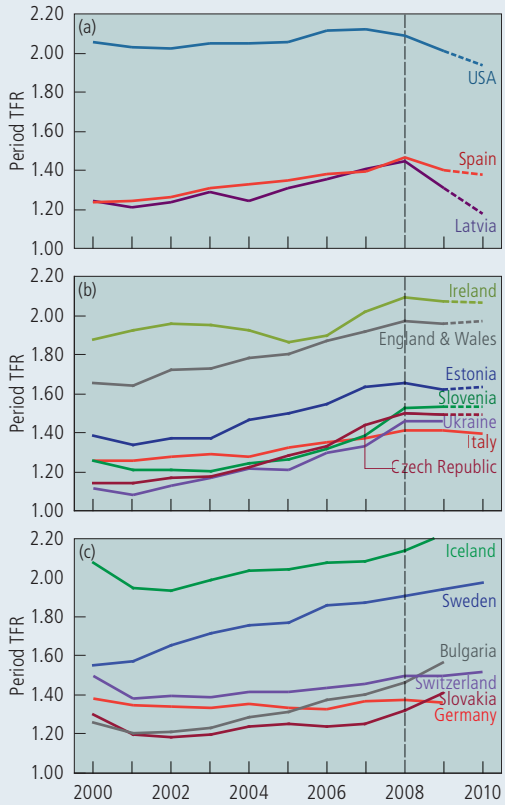
Rising fertility in the developed world has been halted by the global economic recession that began in 2008. Following a decade of generally rising fertility after 1998, new IIASA research finds that the first major recession since the 1970s has brought a sudden trend reversal to fertility rates in several highly developed countries including Spain and the USA (see graphs, *right*). In addition, a larger group of countries including England, Wales, Ireland, Italy, and Ukraine have seen fertility rates stagnate.

The study, conducted in collaboration with the Vienna Institute of Demography, shows that individual reactions to the recession vary by sex, age, number of children, education level, and migrant status. Researchers noted, however, some general patterns of behavior such as a decreased likelihood of the young and childless having children during recessions. Highly educated women react to employment uncertainty by adopting a "postponement strategy" to having babies, especially if they are already childless. In contrast, less educated women often maintain or increase their fertility under economic uncertainty. The patterns differ for men—those with low education and low skills face increasing difficulty in finding a partner or in supporting their family and often show the largest decline in first child birth rates.

In the world's most developed countries, which have been hardest hit by the recession, researchers found that a rise in unemployment and employment uncertainty was a key factor behind the faltering fertility trend. And, interestingly, a change in unemployment or consumer confidence mattered more for fertility changes than the levels of these indicators. "In many developed countries," IIASA's Dr. Vegard Skirbekk warns, "cuts in social spending driven by the need to address ballooning budget deficits may prolong the fertility impact of the recent recession well beyond its end." ■

**Further information** Sobotka T, Skirbekk V, Philipov D (June 2011). Economic recession and fertility in the developed world. *Population and Development Review* 37(2):267–306 [doi:10.1111/j.1728-4457.2011.00411.x].

**Dr. Vegard Skirbekk** is Leader of the Age and Cohort Change Studies Project in IIASA's World Population Program.




**PERIOD FERTILITY TRENDS** during the recent economic recession in selected countries of Europe and the United States: (a) Trend reversal; (b) Fertility rise interrupted; (c) No clear change in fertility trend.

CITIES

# Pooling plan to counter disaster risk

By 2030 some 500 million Asians are expected to live in megacities—urban areas with populations exceeding 10 million. Disaster risk—from earthquakes, cyclones and flooding—is a key threat to such dense urban spaces and the predicted risk to a number of megacities is high. For example, Istanbul is considered very likely to experience strong shaking from a large earthquake in the Sea of Marmara in the next three decades, while several megacities in Japan and China are exposed to tropical cyclones and Mumbai is in danger of urban flooding.

Tackling urban disaster risk, particularly in megacities, is now a high priority issue. "Interest has recently been voiced in exploring whether megacity disaster risk may be suitable for a regional risk pooling scheme, broadly similar to the Caribbean Catastrophe Insurance Facility (CCRIF)," states IIASA's Dr. Stefan Hochrainer-Stigler.

The CCRIF was set up by 16 Caribbean countries in 2007 as the world's first multi-country catastrophe insurance pool to provide governments with immediate liquidity in the aftermath of hurricanes or earthquakes. The pool reduces premium costs by up to 50 percent for participating countries because governments acting together can negotiate reinsurance terms for their pool at a significantly lower cost than if they were to purchase insurance separately. A further benefit of risk pooling is that early cash claim payments received after a disaster event can help to overcome the typical post-disaster liquidity gap.

Researchers examined whether initiatives such as the CCRIF could provide a blueprint for a megacity disaster risk pool in Asia and elsewhere. They concluded that there may indeed be a case for risk pooling, but several hurdles need to be overcome before such schemes could be progressed. In particular, the case for risk pooling needs to be better established with thresholds to be determined, risks clearly defined, and financial authority better segmented. ■

**Further information** Hochrainer S, Mechler R (2011). Natural disaster risk in Asian megacities. A case for risk pooling? *Cities* 28(1):53–61 [doi:10.1016/j.cities.2010.09.001].

**Dr. Stefan Hochrainer-Stigler** and **Dr. Reinhard Mechler** are Research Scholars in IIASA's Risk, Policy and Vulnerability Program.

POPULATION

# Pakistan faces choice: Education or unrest

Low investment in Pakistan's education system is placing the country at increasing risk of political violence. If Pakistan does not manage to dramatically slow population growth and educate its children, it will be faced with a large uneducated working age population that will increasingly put the country at risk of political unrest.

Evidence shows that large youth cohorts have been associated with higher risks of political violence in developing countries where young people have few alternatives to unemployment and poverty. "Pakistan is at risk of similar destabilization," states IIASA's Dr. Anne Goujon. "The other danger is that the country will be stuck in a poverty trap, where low levels of education and high population growth rates prevent it from driving the road to higher development."

Pakistan's education system has disappointed in terms of provision and quality because of the lack of involvement of the state in improving education. From 2000–2005 the Pakistan government spent less than two percent of GDP on education. In 2005, just over one-third of working-age men and 64 percent of working-age women had received no education (see Table).

**EDUCATIONAL ATTAINMENT IN PAKISTAN** Working age population (20–64), in percent (*Source*: IPUMS and DHS).

| Census | Sex | No education | Primary, incomplete | Primary, complete | Lower secondary | Upper secondary | Higher education |
|---|---|---|---|---|---|---|---|
| 1972 | Male | 68 | 3 | 10 | 14 | 3 | 2 |
| | Female | 92 | 1 | 3 | 3 | 1 | 1 |
| 1981 | Male | 66 | ... | 12 | 16 | 3 | 3 |
| | Female | 88 | ... | 5 | 5 | 1 | 1 |
| 1998 | Male | 48 | 6 | 12 | 24 | 5 | 6 |
| | Female | 74 | 4 | 7 | 10 | 3 | 3 |
| 2005 | Male | 34 | 5 | 15 | 29 | 8 | 9 |
| | Female | 64 | 3 | 11 | 13 | 4 | 5 |

The speed of change in improving education must increase *dramatically* if Pakistan is to achieve the Millennium Development Goals, set for 2015, by 2050, Dr. Goujon insists. Future investment must target two particular areas of concern: adult illiteracy and female education. On a positive note, Pakistan's increasingly favorable age structure means that, as of 2025, its large labor force, if well educated, could be a major asset in terms of driving economic development forward. ■

**Further information** Goujon A, Wazir MA (2011). Human capital and population development: Pakistan and the "cannon or butter" dilemma. In: Hummel LJ, Wolfel RL (eds), *Understanding Pakistan through Human and Environmental Systems*. U.S. Army War College Center for Strategic Leadership, West Point, NY pp.157–181.

**Dr. Anne Goujon** is a Research Scholar and **Mr. Asif Wazir** a Guest Research Scholar in IIASA's World Population Program.

POPULATION

# Gender attitudes linked to larger families

Does increased gender equity make people want more or fewer children? A new study of Finland—a country with a relatively high level of gender equity in both public and private life, and thus well into the second phase of the so-called gender revolution—examines this question. Findings point to an interesting conclusion: both traditional and egalitarian attitudes to gender raise Finnish men's expected fertility. Conversely, the impact of gender attitudes is smaller and more ambiguous among Finnish women.

While recent studies predict that fertility will rise as gender equity within families increases, the actual impact of family gender equity and egalitarian values on fertility is unclear, states IIASA's Dr. Stuart Basten, one of the study's authors. Why, for example, should gender egalitarian attitudes increase men's fertility aspirations, given that, among other things, it would involve them in more domestic work?

In the study, researchers investigating the relationship between the egalitarian attitudes and fertility intentions of Finnish men and women with no children or only one child found that gender role attitudes were not significantly associated with the intention to have a first child and were even less marked regarding the intention to have a second.

Gender attitudes, however, did have a clear and significant impact on the ideals and intentions of men and women to have three or more children. "Our findings indicate a tentative U-shaped association between gender attitudes and fertility among Finnish men," Dr. Basten points out. Both traditional and egalitarian attitudes raise men's fertility intentions to have three or more children. Interestingly, however, researchers found that Finnish women with traditional gender attitudes did not want more children, while mothers with egalitarian gender values showed signs of having higher childbearing ideals and intentions. ■

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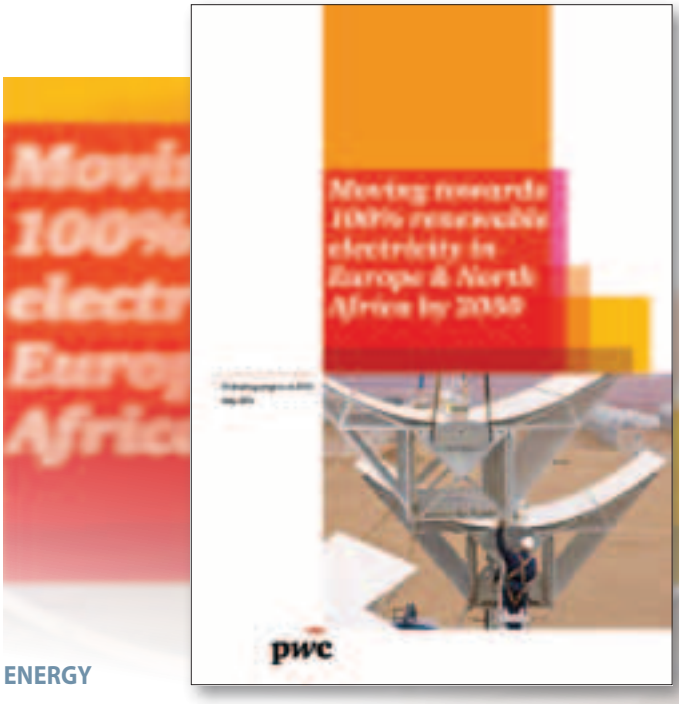
**Further information** Miettinen A, Basten S, Rotkirch A (2011). Gender equality and fertility intentions revisited: Evidence from Finland. *Demographic Research* 24(Art.20):469–496 [doi:10.4054/DemRes.2011.24.20].

**Dr. Stuart Basten** is an Associate Research Scholar in IIASA's World Population Program.




ENERGY

# Evaluating progress on renewable electricity goals

Progress toward achieving very high penetration rates of renewable electricity in Europe and North Africa by 2050 is largely good, according to a collaborative report between IIASA, the Potsdam Institute for Climate Impact Research (PIK), and the advisory firm, PricewaterhouseCoopers (PwC). "Moving towards 100% renewable electricity in Europe & North Africa by 2050" examines whether the vision of a full renewable electricity supply for Europe and North Africa moved closer or further away during the 12-month period beginning March 2010.

According to the report, positive trends and developments outweigh negative ones, particularly in terms of political leadership and technological progress. The integration of markets has also moved at a good pace and in the right direction. In other areas, argues IIASA's Anthony Patt, the impacts of developments are mixed and progress is more fragile. "Market competition and infrastructure permitting and planning processes are the areas of greatest concern," Dr. Patt points out. "Indeed, the lack of progress on improvements to permitting and planning processes is the single biggest threat to the future major expansion of renewable technology in Europe and North Africa." Other potential obstacles are presented by issues associated with project investment and the need for continued market reform to promote access and competition.

All of these areas, along with the engagement of stakeholders and interest groups to increase public acceptance, need to be tackled urgently if Europe and Africa are to stay on track to an ambitious renewable electricity vision by 2050, the report concludes. ■

**Further information** Patt A, Lilliestam J, et al. (2011). Moving towards 100% renewable electricity in Europe & North Africa by 2050. Report by PricewaterhouseCoopers (PwC), funded by the Smart Energy for Europe Platform (SEFEP). Available online at www.pwc.com/sustainability.

**Dr. Anthony Patt** is a Senior Research Scholar and **Mr. Johan Lilliestam** a Research Assistant in IIASA's Risk, Policy and Vulnerability Program.

# Complexity & revolution

**Civil disturbances like the recent unrest in Athens over the Greek government's plan for austerity measures to qualify for a European Union bailout *appear* to stem from public discontent with the failure of government policies. But this explanation is too simplistic. It doesn't address the "root" cause of collapse in the social system, namely, the widening "complexity gap" between the government and its citizens.**

Some years back, American archaeologist Joseph Tainter theorized that societies respond to crises by committing resources like money or enormous efforts to solve the problems they encounter. The more resources that are thrown at a problem, the greater the bureaucratic structures become. This continues until all resources are being used to maintain these structures, at which point the society collapses under its own weight.

Tainter uses ancient Rome as an example of a society that poured political and military power into efforts to control the plebeians and conquer neighbors to fill their tax coffers. Ultimately, Rome's entire resources were used to try to maintain an ever-growing, far-flung empire that was, in fact, too complex to be sustained.

The *Law of Requisite Variety (Complexity)* states that in order to fully regulate/control a system, the complexity of the regulating system has to be at least as great as the complexity of the system to be controlled. If the gap is too big (in either direction) there'll be trouble, almost always in the form of an X-event (extreme event). So, if the complexity gap between the stagnant level of government complexity and the growing level of general-public complexity becomes too great to be sustained, events like the ouster of the Mubarak and Qaddafi regimes will occur. Some scholars, like historian Paul Kennedy, have argued that the American Empire is in the process of coming undone for much the same reasons.

When a society collapses, it quickly loses complexity. The range of social roles and behaviors open to the population dramatically shrinks, leading to a rapid reduction in living standards. Without complex institutions, infrastructures, technologies, and social roles, large populations cannot be sustained at their previous standard of living.

In societies sharply divided in terms of wealth, the "haves" lead a high-complexity style of life that doesn't rely on government to supply common needs like recreational facilities, education, security, or medical care. However, the "haves" also fear a strong government, especially a government that would reduce their complexity by raising taxes. Such a move would ultimately also lead the "have-nots" to see the already-low complexity of their lives becoming lower, and the sense of living in an unjust system with shrinking opportunities creating feelings of alienation.

Over the next couple of years, a good guess is that as people lose confidence in the ability of their governments to solve the financial crises and experience other social stresses that widen the government–public complexity gap, they'll break out into violent protests and/or assaults on those they see as responsible for their misery—government officials and bankers, most definitely, but also perhaps immigrants, ethnic and religious minorities, landlords, and corporate managers and bosses.

More than 50 years ago, the political scientist James C. Davies suggested that social unrest takes place when a society's hopes are suddenly dashed. The first step in identifying the "danger zone" is to look for turning points in this social mood as an indicator of the point at which the mood begins to roll over from positive to negative.

That's the point at which the society can "tip" from hope to despair, and where a civil disturbance becomes much more likely than not. ■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Condensed from an article that appeared in the Austrian newspaper *Der Standard* on 16 April 2011.

**Further information** Casti J (2010). *Mood Matters: From Rising Skirt Lengths to the Collapse of World Powers.* Copernicus Books, New York.

**Dr. John L. Casti** is a Senior Research Scholar in IIASA's X-Events Project. His new book, *X-EVENTS*, will be published by HarperCollins in 2012.

# publications

*IIASA's online publications catalog is available at www.iiasa.ac.at/Publications*


## Urbanization and environment in China

Rapid growth and globalization have dramatically accelerated urbanization in China. IIASA researchers Landis MacKellar, Gui-Ying Cao, and José Siri are co-editors of a *Population & Environment* special issue on the links between this phenomenon and the environment. The journal, to be published in December, includes papers examining the implications of the rapidly growing urban populations' demand for water, food, energy, and other natural resources.

MacKellar L, Cao G-Y, Siri J, Song Xianming (eds) (2011). *Population & Environment* 33(2). Special Issue: Urbanization and Environment in China.


## Assessing vulnerability to climate change in drylands

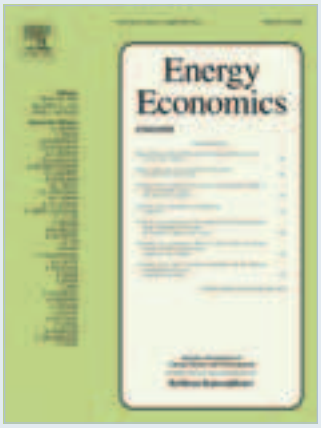
Over 40 percent of the earth's land surface are drylands that are home to approximately 2.5 billion people. Research suggests climate change–induced drought events may push dryland systems to cross biophysical thresholds, causing a long-term drop in agricultural productivity. An *Ecology and Society* special feature conducted a structured comparison of how livelihood systems in different dryland regions are affected by drought, and how these regions may be vulnerable to climate change.

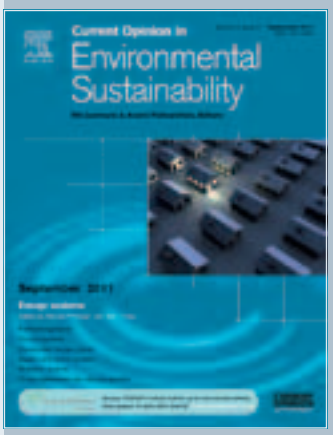
Fraser EDG, Dougill AJ, Hubacek K, Quinn CH, Sendzimir J, Termansen M (eds) (2011). *Ecology and Society* 16(3). Special Feature: Resilience and Vulnerability of Arid and Semi-Arid Social Ecological Systems.

## New technologies needed to combat global warming

IIASA Deputy Director and energy economist Nebojsa Nakicenovic has co-edited, with Yale University's William Nordhaus, a special issue of the journal *Energy Economics* that contains a collection of articles on the economics of technologies to combat global warming. The papers, the authors note, point to the need to "develop and deploy alternatives to existing technologies on a very large scale."

Nakicenovic N, Nordhaus W (eds) (2011). *Energy Economics* 33(4):565–708. Special Issue: The Economics of Technologies to Combat Global Warming.

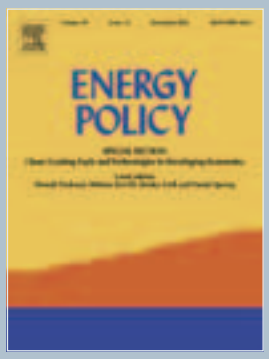



## Energy security & energy access: Interconnected global challenges

Energy access and energy security are critical issues for policymakers globally, affecting livelihoods in the developed and the developing world. IIASA's Shonali Pachauri is co-editor of a special edition of *Current Opinion in Environmental Sustainability* that explores many aspects of energy, including: the scale of the energy access challenge, gender dimensions, and financing options to ensure the sustainability of energy access efforts.

Pachauri S, Cherp A (eds) (2011). *Current Opinion in Environmental Sustainability* 3(4):199–278. Special Issue: Energy Systems.




## Clean cooking fuels and technologies for the poor

IIASA's Shonali Pachauri co-edited a special issue of *Energy Policy* which examines how to improve access to clean fuels and stoves. With more than 3 billion people still dependent on traditional solid fuels to satisfy their daily needs for cooking, there is an urgent need to address this issue. The special issue analyzes, among others, the successes and failures of past policies and programs to improve access to clean fuels and stoves, analytical and decision frameworks for analysis of the access issue, strategies and business models of suppliers of modern fuels and technologies, and making energy provisioning a central component of development strategies.

Pachauri S, Zerriffi H, Foell W, Spreng D (eds) (2011). *Energy Policy* 39(12). Special Issue: Clean Cooking Fuels and Technologies in Developing Economies.


## Details underpinning global climate scenarios published

A special issue of *Climatic Change*, co-edited by IIASA's Keywan Riahi, outlines four new scenarios of future emissions of greenhouse gases, air pollutants, and land-use change, which will be used by the climate modeling community to develop the next generation of climate simulations. The "Representative Concentration Pathways" are available at the RCP Web-database, hosted by IIASA for the Integrated Assessment Modeling Consortium (IAMC).

van Vuuren DP, Edmonds JA, Kainuma M, Riahi K, Weyant J (eds) (2011). *Climatic Change* 109(1–2):1–241. Special Issue: The Representative Concentration Pathways in Climatic Change.

# The ripple effect

## IIASA's Annual Fund is benefiting not only young scientists, but also populations in developing and low-resource areas.

In years gone by, **Prestige Makanga** probably wouldn't have made it to IIASA's Young Scientists Summer Program (YSSP). A young Zimbabwean, working as a Researcher at the African Centre for Cities at the University of Cape Town, Prestige wouldn't have received regular YSSP funding, and he would have missed out on what he calls a "rewarding" and "intellectually stimulating" YSSP experience.

Thanks to IIASA's Annual Fund, however, and the generous contribution made to it by numerous individuals, including former YSSPers themselves, Prestige was able to benefit from interacting with experienced researchers and young scientists from many diverse backgrounds as he pursued research on the use of volunteered geographic information to understand injury in low and middle income countries. The experienced IIASA researchers who mentored him, says Prestige, gave an enormous boost to his thinking on what research pathways to follow in the future, especially for his PhD, while the friendships and contacts he made with his peers gave him a much better insight into the cultural diversity that exists in the world. "The important realization is that we are all trying to solve similar global problems and all of us have much to offer," he remarks.

International friendships with other young scientists is a YSSP benefit stressed by another Annual Fund recipient, **Shahriar Rahman** from Bangladesh. He credits IIASA highly for providing the space and time for work and personal contacts with the 55 or so talented young scientists who came to IIASA in summer 2011. Shahriar was particularly impressed with the interdisciplinary background and the opportunities he had to see his own work on drinking water demand and availability in southwestern Bangladesh from several different scientific perspectives, as afforded by both his experienced scientific mentors and the other participating students.

**Anastasia Emelyanova** probably would have made it, being a talented student from Russia and thus a potential YSSP candidate. However, the award to Anastasia of the Petr Aven Fellowship, which offers an advanced graduate student from Russia or a developing non-IIASA member country the opportunity to participate in the Young Scientists Summer Program, made it an experience to remember. "The personal and professional growth I experienced here," she says "is beyond any estimation. Personally, I think that being at IIASA pushes you to learn how to communicate with people effectively. This is great, not just for being able to spend time with people who share your interests, but also for building contacts for future work. There are so many possibilities for young researchers to collaborate with each other to work for the benefit of their homeland."

Every year, there are many applicants for YSSP places, and the Annual Fund provides an opportunity to increase the scope and vision of the YSSP. There will be a Petr Aven fellowship for the next nine years, but how many other places there will be depends very much on the generosity of donors like Petr Aven who, many years after his YSSP experience, is still aware of the influence his participation in the program had on his life.

Prestige Makanga

Anastasia Emelyanova

# capacity building

Shahriar Rahman

Other YSSPers have had a similar experience. One anonymous YSSP donor remarked: "My reason for giving is very simple. The YSSP provided me with a platform for my research, as well as my doctorate dissertation. This was my first experience with international scientists, and I had many fruitful discussions, particularly in the area of energy and systems analysis."

As Anastasia hints, the Annual Fund offers much more than extending expertise and useful contacts to young scientists from non-IIASA countries. **Prestige Makanga** has been in touch with his home country embassy in Vienna to tell them about IIASA and the YSSP program and how such a program can benefit the country. "I will also be teaching an undergraduate course and I am planning to use some of the IIASA models and tools for lectures. This will greatly benefit the students."

Prestige's work on deaths that occur in the world as a result of injury is also vital for the future of low and middle income countries like his own. Some 90 percent of all accidental deaths in the world occur in these nations, outnumbering all deaths from HIV/AIDS, malaria, and tuberculosis deaths put together. In countries trying to cross the development threshold, collecting statistical information must have seemed like a luxury when many were scraping a living. However, Prestige believes that using the Volunteered Geographic Information (VGI) phenomenon, which thrives on user-generated content, is an efficient and viable way of quickly generating useful data when research resources are low. "I believe that there will be a ripple effect, and as my research outputs aim to address pressing societal challenges, my experience at IIASA will later have social benefits."

In Bangladesh, the experiences at IIASA of **Shariah Rahman** will contribute greatly to the use of systems analysis for problem solving. The outcome of his YSSP research will be an integrated drinking water security model considering all important factors (hydrological, environmental) with their associated uncertainties. "The coastal area of Bangladesh is very vulnerable," he says. "Salt water from the sea often seeps into the drinking water supplies used by coastal households, especially in the southwest of the country. The rural livelihoods strongly depend on water and there has never been a proper assessment of water supply and demand."

These experiences of research gaps in the "South" are mirrored by the research carried out by **Anastasia Emelyanova** into aging in the Arctic population of the Russian Federation, where conditions are generally quite different from the rest of Russia. Anastasia collected data before coming to IIASA and was able to spend her time modeling "aging" indicators comparing chronological age with "prospective" age. This work, which was pioneered at IIASA, views age as the years you statistically have left to live rather than the years you've already lived and can have quite a profound impact on the provision of social policies. Says Anastasia: "The Russian North has few resources for adjusting to the consequences of population aging and has given aging a rather low policy priority." Her results did indeed show life expectancy picking up during this decade for both men and women in the northern regions, posing potential problems for Russian policies on aging and elderly wellbeing.

"The results I got turned out to be very different from those which I expected, applying new metrics introduced here in IIASA. The World Population people gave me lots of wise thoughts on the projects and representation of results at the final workshop."

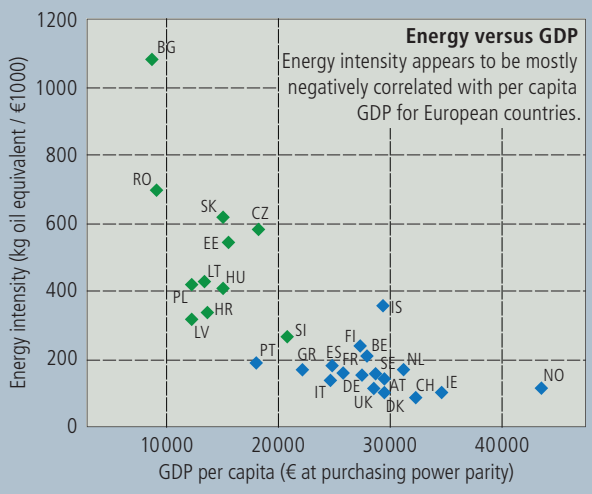
The Annual Fund has proven to be a very worthwhile investment in summer 2011 for three young people, who will not only benefit in career terms from the three months spent at IIASA, but will also bring tangible benefits to their home countries, both those studying science and those who will benefit from its insights.

To bring even more young scientists to IIASA next year, donations are needed to reach the €5,500 required for flights to and from Austria, accommodation, and living expenses while here. ■

**Further information** To make a donation to IIASA's Annual Fund, visit www.iiasa.ac.at/donate. To apply for the YSSP, visit www.iiasa.ac.at/yssp.

**The EU's ability to measure progress toward economic and sustainability goals is being improved thanks to a new project that links economic indicators with measures of sustainability and wellbeing:**

# IN-STREAM

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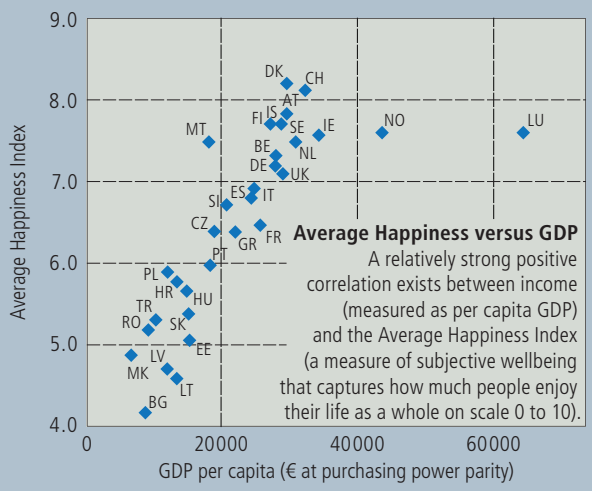


Mainstream economic measures such as GDP, although influential, offer only a partial picture of human wellbeing. GDP, after all, was never intended to serve as a measure of people's welfare. Increasingly, therefore, Europe's policymakers are looking for indicators and measurement systems that provide a more comprehensive picture. Developing such a system is the goal of the research project IN-STREAM—INtegrating MainSTREAM Economic Indicators with Sustainable Development Objectives—which involves eight research partners from six countries and was funded from the European Community's Seventh Framework Programme.

"Society would benefit from improving our ability to assess the wellbeing of people and to measure the multiple dimensions of progress through the use of a variety of indicators that go 'beyond GDP,'" explains Eva Hizsnyik, who worked on IIASA's contribution to IN-STREAM. "Alternative metrics are needed that help us assess our progress toward the simultaneous objectives of economic success, human wellbeing, environmental protection, and long-term sustainability."

To go "beyond GDP," the IN-STREAM project has examined some 70 economic, social, and environmental indicators. Researchers assessed the quantitative relationships between mainstream economic indicators and alternative measures. "The main objective of this statistical analysis was to gain a better understanding of the linkages, especially synergies and trade-offs between sustainability goals and mainstream economic performance benchmarks—with some interesting results," Ms. Hizsnyik points out.

To a large extent, analysis confirms some expected correlations. As the top chart (*left*) illustrates, energy intensity appears to be mostly negatively correlated with per capita GDP. In other words, as societies become more affluent, they use less energy to produce one unit of GDP. However, the correlations also highlighted some less well-known relationships, including a relatively strong negative correlation between the employment rate (defined as the share of those in the 15–59 age group who are employed) and the unemployment rate (the fraction of those who would like to work but cannot find a job). Analysis indicates that the higher the employment ratio, the lower the share of people who are unemployed, implying that more employment creates more jobs. Clearly, this refutes the argument that there is a limited number of jobs in the economy and that early retirement would help the young generation find employment.

Analysis further reveals that money does play an important role in determining happiness for many people after all. As the bottom chart (*left*) shows, a relatively strong positive correlation exists between income (measured as per capita GDP) and the Average Happiness Index (a measure of subjective wellbeing that captures how much people enjoy their life as a whole on scale of 0 to 10). Relatively low income levels (below €15,000 per capita) tend to be associated with much lower Average Happiness values (in the range of 4 to 6), while in countries with higher income levels (€25,000 per capita and above), the Happiness Index values are also significantly higher (from 7 to 8 and above).

"One of the most interesting findings from this work is that despite its recognized deficiencies, GDP is an important component of many 'beyond GDP' indicators," Ms. Hizsnyik states. GDP influences the values of the "beyond GDP" indicators directly (by direct inclusion as a component of a composite index) or indirectly (as a driver behind the processes represented by an indicator or composite indicator).

What this means is that many social and some environmental indicators/indices correlate with GDP, at least to some extent. Analysis from IN-STREAM supports the conclusion that economic, social, and environmental factors can work in tandem rather than in opposition, which is a relevant insight for the "beyond GDP" debate. ■

**Further information** www.in-stream.eu

**Ms. Eva Hizsnyik** is a Research Scholar in IIASA's Ecosystems Services and Management Program.

# Pavel Kabat

**Professor and Chair of Earth System Science and Climate Change Group, Wageningen University, the Netherlands; Director of the Royal Dutch Academy of Sciences and Arts Institute for Integrated Research on Wadden Sea Region**

**As of 1 February 2012: Director, IIASA**

"My career is based on bringing together different academic disciplines and reaping the rewards," begins Pavel Kabat as he explains to *Options* why becoming Director of IIASA is the perfect step in his professional career.

Born in former Czechoslovakia in 1958, Pavel has lived and studied in Prague, Canada, the USA, and the Netherlands, where he has lived since 1986. Growing up on both sides of the Iron Curtain nurtured his desire to fully understand the world about him and triggered his passion for reading that remains today—Pavel "devours" up to three books a week, anything from poetry to history to science.

As a secondary school student, Pavel became fascinated by mathematics and slowly began applying it to his understanding of the real world around him. However, it wasn't enough for the young Pavel and left him deeply unsatisfied: "I realized maths only supplied part of the answer; I needed other knowledge from both the natural and social sciences to understand the whole picture."

Pavel holds two Masters and two PhD degrees, in mathematics, hydrology, water resources, and amelioration. Around 1986, he became interested in climate change while starting his research career in the Netherlands. At that time climate scientists focused merely on the role that the atmosphere and oceans played in the climate system. The role that land and water played was not well understood and certainly not integrated with the global atmospheric and oceanic circulation models, which are key to studying climate change. Pavel set out to address this gap by co-leading a series of large scale earth system experiments from 1990 to 2005 in Africa, Europe, and South America to better understand how the entire earth system works and how it can be developed in a sustainable way.

And it is this experience, of leading large teams of scientists from different disciplines and countries, that has seen Pavel chosen to direct activities ranging from the international scientific steering committees of two IGBP (International Geosphere–Biosphere Programme) programs (since 1994) to the International Dialogue on Water and Climate (2001–2009), established by UNESCO, WMO, and WWC. "My management style is one of getting the right people to work together through convincing thematic arguments and focusing on the results," he explains.

Pavel officially becomes IIASA's tenth Director on 1 February 2012, but he is already working closely with current Director Detlof von Winterfeldt and has started getting to know the Institute by taking part in the Science Advisory Committee meeting, the Council meeting, and the US NMO Committee meeting. "It is hard to leave my current role at the University of Wageningen, but I would also have liked to start work at IIASA yesterday," says Pavel.

Between his busy schedules, Pavel likes to spend time with his family. He is father to two sons (aged 35 and 25) and will come to live in Laxenburg accompanied by his partner, Anneke, and their Boxer dog, Sheila. ■

### A day in the life of Pavel Kabat

**06:00** Wake up; long shower session.

**07:00** Walk Sheila, his Boxer, then have breakfast.

**07:30** Prepare for lectures, presentations, meetings.

**08:30** Briefing with PA and get ready for first meeting.

**09:00** Every day is different! A full day in the office in Wageningen happens once a week and is filled with meetings with Pavel's 35 PhD students, consultations with project leaders and other staff, and many calls and teleconferences. Half the week is usually spent attending meetings all over the Netherlands, mainly associated with his Chairmanship and Directorship of several National Research Programmes and Institutions. Pavel travels for up to three months a year, where he spends his days presiding over Steering Committee meetings, giving key note presentations at major conferences, or advising and evaluating Science Academies and Governments around the world.

**19:00** Dinner at home (if he's lucky, three times a week) or a meeting over dinner somewhere in the world.

**23:30** Read and bed time.

…And when Pavel has a free moment in the evenings or at the weekends, he writes and edits science papers, books and reports; answers email; consults PA (24/7); and reads…

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