

**Directions  
for  
Africa**  
The paths research reveals

**Education and development**

Pages 12–15

**Eliminating energy poverty**

Pages 18–19

**Conflicts and nation-building**

Pages 20–21

**Investing in health care**

Pages 22–23



Leen Hordijk  
Director, IIASA

## Arrivederci!

**F**aced with the need to learn another language—Italian—I began musing on the age-old conundrum of whether Dutch people are hard-wired to learn “other” languages or whether, in fact, “other” nationalities are hard-wired *not* to learn Dutch!

For me, working at IIASA over the past six years has involved using several languages, mainly English. When, 35 years ago, it came to a choice between Russian and English as the Institute’s “mother” tongue, the Russians graciously agreed to English. But at any given time, there are 30 plus nationalities working at IIASA, which could make language issues a challenge.

Yet it doesn’t. Talking to each other is something that we do well at IIASA. Our working philosophy is that scientists should talk—outside their own disciplinary boxes—and this often results in astonishing solutions to seemingly intractable problems. Moreover, the regular program leader meetings have paid dividends in terms of generating ideas for, and implementation of, new cross-cutting projects, such as the Greenhouse Gas Initiative and Water Activities.

If internal talking has made IIASA stronger, then talking to the outside world has reinforced those strengths. For example, the recent report of the External Evaluation Committee reviewing IIASA research activities 2001–2005 within the theme “Population and Society” not only shows the remarkable level of achievement by individual programs, but also suggests diverse new ways of integrating and sharing the wisdom developed by different groups.

The IIASA Conference ‘07—“Global Development: Science and Policies for the Future”—was “talking” at its finest. The Conference, a successful showcase for IIASA’s work, also encouraged scientists and policymakers from North and South to talk to us about their problems and possible future directions for our work, both geographically and methodologically.

At the Conference, I was struck by what Professor Manfred Max-Neef said regarding the need for a “profound language shift” in our society if global poverty and the unprecedented “destruction of ecosystems and biodiversity” are to be overcome. Though he did not once use the term “globalization” in his speech, this was, I believe, implicit in what he was saying.

Globalization is not to everyone’s liking, but it is here to stay and IIASA is part of it. Our recent spate of new National Member Organizations—India, Pakistan, South Africa, and Korea—bears witness to that. But perhaps we should start to contemplate whether the current language of globalization can adequately encompass IIASA’s aspirations for the future.

And while IIASA expertise is needed for research that spans countries and continents, a great deal of our work is still at the regional level, with some examples to be found in this issue of *Options*.

Although it is good that IIASA talks globally, my hope is that the Institute will never forget the importance of its regional accents and local dialects.

*Arrivederci, a presto spero, mi mancherete molto.* ■

### About IIASA

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

IIASA’s scientists research

- energy and technology;
- environment and natural resources; and
- population and society.

IIASA produces

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

IIASA helps

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

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

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

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## 2 editorial

*Arrivederci!*

## 4 research highlights

Air pollution from shipping ■ Managing fisheries-induced evolution ■ IIASA at COP 13 ■ New leaders for IIASA ■ Growing older faster

## 6 research in the pipeline

QUEST for mitigation ■ CC-TAME for change ■ Optimizing EU policy ■ Verifying nuclear non-proliferation ■ SCENES of the future ■ Transformation of the American religious landscape ■ Modeling biodiversity evolution

## 8 work in progress

Turn out the lights, the party's over  
On the fragility of infrastructures crucial for modern life

## 10 getting research into practice

### 10 IIASA Policy Briefs

A new series of publications

### 11 Preparing Madagascar for cyclones

Reducing the impact of natural disasters on the Malagasy economy

## 28 iiasa news

Death of Bert Bolin ■ IIASA forester influences international policy ■ IIASA scientists right on message ■ Nobel Peace Prize: IIASA scientists among winners ■ YSSP: 2007 awards announced ■ Republic of Korea joins IIASA ■ Reducing IIASA's carbon footprint

## 30 iiasa alumni

W. Brian Arthur ■ Paul J. Crutzen ■ Serguei Glaziev ■ Martin Parry ■ David G. Victor

## 31 day in the life

### Food for thought

When IIASA's busy postdoctoral researchers spend an evening together, food choices can be wide-ranging: from curry to sushi and from fish and chips to feijões



Cover photo  
© Oskar Franklin | <http://oskarf.com>

## 12 feature articles

### 12 Education—the key to development and health in Africa

IIASA's World Population Program recently completed research which, for the first time, scientifically proves the key role of human capital formation in a country's economic development.

### 16 Climate change and agriculture in Africa

Climate change poses serious threats to food production in Sub-Saharan Africa and risks further impoverishing many of the world's poorest countries. IIASA's research addresses the food security and climate change challenges for this region.

### 18 Making energy poverty history in Africa

The challenge of increasing Africans' access to affordable and reliable energy services, while taking environmental constraints into account, is colossal.

### 20 Transforming Africa's conflicts into nation-building projects

Protagonists must shift the use of power from mutual destruction to the joint design of political, social, and economic systems.

### 22 Analyzing health infrastructure investment in Lesotho

An investigation into the benefits of a multimillion dollar investment in Lesotho's health care infrastructure estimates it will result in an extra one million life years lived in the kingdom between 2010 and 2019.

### 24 Making climate forecasts useful in a changing climate

Farmers in Zimbabwe benefit from seasonal weather forecasts by planting higher-yielding, water intensive crop varieties in years when good rains seem likely.

### 26 Globalization and Africa's forests

The increased utilization of Africa's forest resources, due to globalization, will substantially increase the pressure on them.

EUROPE'S AIR

## Air pollution from shipping

Air pollution emissions from marine shipping around Europe could surpass the volume of land-based emissions within the next few decades, unless targeted countermeasures are taken. The research findings from IIASA's Atmospheric Pollution and Economic Development (APD) Program show that the air quality targets established by the EU Thematic Strategy on Air Pollution



© Rob Bouwman | Dreamstime.com

could be achieved at lower cost if emission controls were also applied to ships in international waters.

The research results were presented to the negotiations of the International Maritime Organization. The research was made possible because of the integrated approach to the control of local air pollution and global

greenhouse gases that has been pioneered by APD. The special analysis was performed using the program's newly developed GAINS (Greenhouse Gas and Air Pollution Interactions and Synergies) model. ■

IIASA's Atmospheric Pollution and Economic Development Program  
[www.iiasa.ac.at/Research/APD](http://www.iiasa.ac.at/Research/APD)

EVOLUTION AND ECOLOGY

## Managing fisheries-induced evolution

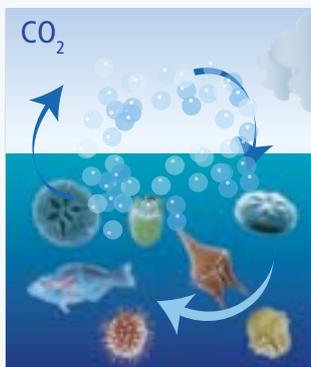
An international group of experts collaborating with IIASA's Evolution and Ecology Program has urged the introduction of evolutionary impact assessments (EvoIAs) for managing fisheries-induced evolution.

In an article in the 23 November 2007 issue of *Science*, the experts summarize mounting evidence that fishing causes rapid contemporary evolution in exploited populations, both in freshwater and in marine environments. These evolutionary changes could magnify the ecological challenges that already threaten sustainable harvesting. The experts propose that EvoIAs, based on statistical analyses and evolutionary models, should be

used to look forward in time and provide quantitative predictions to compare alternative management options.

With fisheries-induced evolution likely to diminish yield and degrade ecosystem services within decades (see figure), successful fisheries management requires the ecological and evolutionary consequences of fishing to be evaluated and mitigated. Adopting this approach, say the experts, will help fisheries managers to rise to the challenge of overexploitation. ■

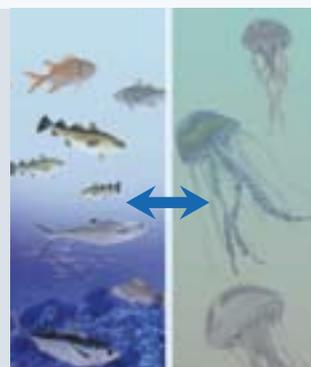
Complete article in *Science*, 318(5854):1247–1248  
[www.sciencemag.org](http://www.sciencemag.org)



**Supporting services**  
 Fundamental indirect or long-term processes



**Provisioning services**  
 Products that humans derive



**Regulating services**  
 Benefits from natural ecosystem regulation



**Cultural services**  
 Values for education, recreation enrichment and aesthetics

**Evolution toward smaller size and earlier maturation might alter:**

- Top-down control of nutrient cycling
- Recovery potential
- Fisheries yield and stability
- Presence or abundance of big fish of special value

- Trophic interactions and geographical distributions
- Pest and invasion control

- Intrinsic value of species and ecosystems
- Recreational fishing experience

**Erosion of natural genotypic and phenotypic diversity might affect:**

- Structure of ecological niches
- Benefits to tourism industry
- Food product diversity

- Resilience to environmental fluctuations
- Adaptability to climate change

- Enjoyment of nature
- Indigenous and local culture

**EXAMPLES OF UTILITY COMPONENTS POTENTIALLY AFFECTED BY FISHERIES-INDUCED EVOLUTION** Aquatic ecosystems produce four categories of ecological services of direct and indirect utility to society. Using these definitions as a basic framework will facilitate discussions among stakeholders with different backgrounds and assist in the prioritization of objectives and actions. Potential effects are shown for the two most ubiquitous effects of fisheries-induced evolution: (i) reductions in body size and maturation age; and (ii) erosion of natural genotypic and phenotypic diversity.

## DEFORESTATION AND DISASTERS

### IIASA at COP 13

Scientists from IIASA's Forestry (FOR) and Risk and Vulnerability (RAV) Programs presented their latest research at COP 13—the 13th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC)—in Bali, Indonesia, from 3 to 14 December 2007.

Michael Obersteiner, Florian Kraxner, and Petr Havlik of FOR organized an IIASA side event entitled "The Political Economy of Avoided Deforestation." The goal of Reduced Emissions from Deforestation and Degradation (REDD), said the FOR scientists, can be achieved by keeping forests intact to protect carbon sinks and to prevent rises in emissions caused by, for instance, peatland degradation and forest fires that are common in the wake of deforestation.

The FOR scientists also showed how the costs of compensating forest owners for not cutting down forests can be balanced against revenue currently lost through, for example, illegal logging. They also examined several related issues, such as afforestation and the expansion of agricultural land, and scenarios linked to the entire land-use sector.

Adaptation to climate change was also negotiated in Bali and RAV scientists Reinhard Mechler and Pablo Suarez provided important input to this debate by suggesting ways forward with options for sharing extreme event risks in developing countries ("climate insurance"). They argued in favor of further developing public-private safety nets for climate-related shocks.

These partnerships would go beyond traditional public-private partnerships in providing disaster safety nets to developing country households, farmers, and governments, and would include governments and private insurers, non-governmental organizations (NGOs), international financial institutions, and other donors. Importantly, they would provide secure, affordable financial arrangements to low-income communities and governments before disasters strike and, among many other benefits, relieve the uncertainty and anxiety of depending on *ad hoc* post-disaster aid for recovery and even survival. ■

IIASA's Forestry Program  
[www.iiasa.ac.at/Research/FOR](http://www.iiasa.ac.at/Research/FOR)

IIASA's Risk and Vulnerability Program  
[www.iiasa.ac.at/Research/RAV](http://www.iiasa.ac.at/Research/RAV)

## IIASA'S NINTH DIRECTOR

### New leaders for IIASA

IIASA is delighted to announce that its Council has enthusiastically appointed Professor Detlof von Winterfeldt as the ninth Director of IIASA, effective 1 January 2009. IIASA is equally fortunate that Professor Sten Nilsson is serving as Acting Director from mid-May through December, assuring that there will be no loss of momentum for IIASA.

Detlof von Winterfeldt is currently Professor of Industrial and Systems Engineering and Professor of Public Policy and Management at the University of Southern California (USC). He is also a founding director of USC's National Center for Risk and Economic Analysis of Terrorism Events.

Winterfeldt brings a wealth of interdisciplinary and international experience to IIASA. Following bachelors and masters degrees in Psychology from the University of Hamburg, he completed his Ph.D. at the University of Michigan and began his research career working in IIASA's Management and Technology and Energy Programs in 1975. After IIASA he moved to California, where he has successfully applied his expertise in decision and risk analysis to the areas of technology development, environmental risks, natural hazards, and terrorism.

Sten Nilsson has been IIASA's Deputy Director since 2002 and Leader of its Forestry Program since 1990. A native of Sweden, Nilsson has had a distinguished academic career in forest sector analysis with an emphasis on policy analysis. Since gaining a Ph.D. in Economic Planning from the Royal College of Forestry in Stockholm, Nilsson has helped numerous countries—from Russia to Europe to Canada to India to China—to better manage their forest sectors. Professor Nebojsa Nakicenovic, Leader of IIASA's Energy and Transitions to New Technologies Programs, joins Nilsson as IIASA's Acting Deputy Director.

Commenting on the appointments, Professor Simon Levin, Chair of IIASA's Council, said: "IIASA has been fortunate to have the leadership of Leen Hordijk over the past six years and is equally fortunate that Sten Nilsson will serve as Acting Director. Detlof von Winterfeldt fits the model of these two dedicated and visionary leaders, and assures a bright future for IIASA." ■



Detlof von Winterfeldt



Sten Nilsson

## POPULATION

### Growing older faster

Although populations will be growing older throughout this century, the speed at which aging will occur will not be steady, according to an article by IIASA researchers Wolfgang Lutz, Warren Sanderson, and Sergei Scherbov in the 7 February 2008 edition of *Nature*.

The article shows how populations will grow older at an accelerating pace, peaking in the decade 2020–2030, and then slowing down after 2030–2050. It also introduces new indicators of aging, looking at the expected time to death rather than the

traditional time since births. This article is exceptionally policy-relevant—the authors stress, for example, the importance of establishing sustainable policies with respect to the financing of pensions and health care for the elderly while such policies are still politically feasible. The changing age composition of the electorate, they say, may make such reforms politically more difficult in the future. ■

Complete article in  
*Nature*, 451(7179):716–719  
[www.nature.com](http://www.nature.com)

**CLIMATE CHANGE**

## QUEST for mitigation

IIASA foresters are examining the scientific basis for forestry-based climate mitigation projects as part of a major research program, Quantifying and Understanding the Earth System (QUEST), coordinated by the Natural Environment Research Council (NERC) of the United Kingdom. The explicit aim of the research is to inform the policy process—by means of analysis, development, and demonstration of relevant methodologies—regarding the sustainable potential of climate change mitigation through (a) carbon stock enhancement through afforestation/ reforestation and forest management, (b) forest conservation (including avoided deforestation), and (c) bioenergy options.

QUEST, which aims to substantially improve predictions of global environmental change, will accelerate development of the next generation of environmental-change models and, as well as providing a focal point for UK work, forge collaborations and synergies between worldwide experts in Earth system research and modeling. ■

QUEST  
Quantifying and Understanding  
the Earth System  
<http://quest.bris.ac.uk>

**FORESTRY**

## CC-TAME for change

“Climate Change—Terrestrial Adaptation and Mitigation in Europe (CC-TAME)”—a recently awarded European Commission project—will see the IIASA Forestry (FOR) Program coordinating a consortium of 17 partner institutions to develop and implement a “policy–model–data fusion” concept for effective greenhouse gas (GHG) mitigation. This concept will be used to readily inform European policymakers during negotiations to implement European policies and to build strategy for future climate policies.

Only a few modeling teams, such as the IIASA RAINS/GAINS communities, have embraced such a policy–model–data fusion

concept in the climate change sphere. Even though the European agricultural sector is the third largest emitter of greenhouse gases, the land use sector is still poorly represented in these models and also lacks an efficient and effective “policy” component in the fusion concept.

The CC-TAME project is designed to fill this gap and help assess the policy effectiveness of reducing greenhouse gases and air pollution emissions, enhancing sinks, providing bioenergy, and, at the same time, increasing ecosystem resilience to climate change-related hazards. ■

IIASA’s Forestry Program  
[www.iiasa.ac.at/Research/FOR](http://www.iiasa.ac.at/Research/FOR)



Photo: Action Team 1991–1998/IAEA

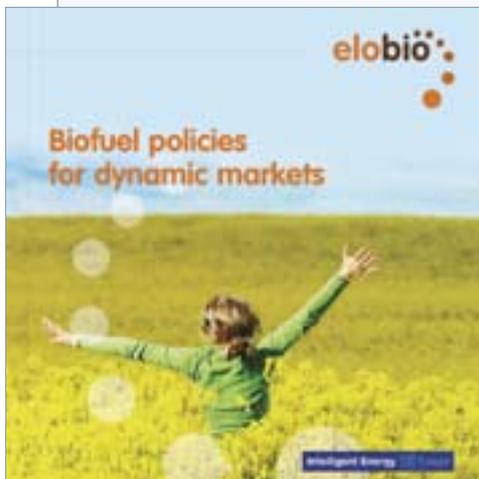
**BIOFUELS**

## Optimizing EU policy

The current market introduction of biofuels is having significant impacts on other commodity markets. As biofuel policies affect large-volume markets—for example, the billion-euro markets for animal feed and vegetable oils—increased demand for biofuels will have potentially significant long-term impacts on several commodity markets, becoming a major barrier for industry and public support for biofuels.

IIASA’s Land Use Change and Agriculture (LUC) Program is one of seven partners in Elobio, a new project that aims to review current experiences with biofuels and other renewable energy policies and their impacts on various markets. LUC will carry out an assessment of biofuel policy impacts on markets for food and animal feed, and there will be other investigations into, for example, biomass markets for power and heat. The results of Elobio will be used for stakeholder-supported development of low-disturbing biofuel policies and provide inputs for the 2008 review of the biofuel directive. ■

Elobio project  
[www.elobio.eu](http://www.elobio.eu)



**NEGOTIATIONS**

## Verifying nuclear non-proliferation

Professor Rudolf Avenhaus, of IIASA’s Processes of International Negotiations (PIN) Network, and Dr. Thomas Krieger, a colleague at the University of the Federal Armed Forces, Munich, Germany, have been invited to collaborate with The Joint Research Center of the European Union in Ispra, Italy. Professor Avenhaus and Dr. Krieger will work in the area of quantitative analyses of verification measures for the nuclear non-proliferation treaty (NPT). More specifically, the effectiveness and efficiency of unannounced interim inspections in nuclear facilities, which are being discussed at present by the International Atomic Energy Agency (IAEA) as well as by Euratom, will be evaluated with the help of game-theoretical methods. The joint work started in 2008, and its first phase should be finished around mid-2009. ■

IIASA’s PIN Network  
[www.iiasa.ac.at/Research/PIN](http://www.iiasa.ac.at/Research/PIN)

## WATER IN EUROPE

### SCENES of the future

IIASA scientists from the Risk and Vulnerability (RAV) and the Land Use Change and Agriculture (LUC) Programs have a key role in the SCENES (Water Scenarios for Europe and for Neighbouring States) project. This multi-faceted project, funded by the EC 6th Framework Programme, addresses the future of Europe's waters in terms of the influence of a variety of environmental, social, political, and policy factors, including changes in climate, population and land use, as well as political, economic, and technological developments.

Key to the project is the development and analysis of a set of comprehensive scenarios of Europe's freshwater futures up to 2050. Consultations with stakeholders and decision makers will help the researchers develop the scenarios. IIASA's RAV staff are designing and running the participatory



process of group model building and guiding the story line development using a range of qualitative modeling methods to formalize stakeholder understanding of the causal mechanisms inherent in the scenarios they examine.

The LUC contribution centers around driving forces. LUC will produce spatial databases of land use, soil, agricultural cropping patterns, and agricultural water demand. The aim is to quantify spatial water demand and use for agriculture, industry, energy, and households, to inform the scenario building process. Once scenario story lines are developed, LUC will work to quantify the story lines developed by the stakeholders. ■

SCENES project  
[www.environment.fi/syke/scenes](http://www.environment.fi/syke/scenes)



## WORLD POPULATION

### Transformation of the American religious landscape

IIASA scientists Anne Goujon and Vegard Skirbekk, in cooperation with Eric Kaufmann of Birkbeck College, London, are currently working on a project to forecast the religious composition of the United States from 2003 to 2043. The analysis uses data from the General Social Survey and employs a set of scenarios based on differential age-specific fertility, migration, and denominational switching rates, as well as variation in the probability of religious transmission from parents to children.

The data allow the researchers to estimate conversion rates as well as migration and fertility by 11 religious categories. The base scenario of the population projections suggests a substantial increase in the proportion of Catholics, mainly due to immigration and fertility. Although the Protestant population will continue to increase in absolute terms, its share in the total population will decline. The secular, "without religion" group remains small, even shrinking slightly by the middle of this century because of low fertility.

As religious factors have a notable influence on demographic behavior (marriage and childbearing patterns), and thus on economic and social trends, this research is expected to be highly policy-relevant. ■

IIASA's World Population Program  
[www.iiasa.ac.at/Research/POP](http://www.iiasa.ac.at/Research/POP)

## EVOLUTION AND ECOLOGY

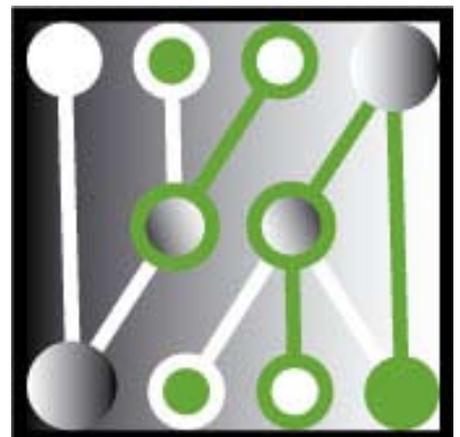
### Modeling biodiversity evolution

There is broad agreement among scientists that global biodiversity is being lost at an extraordinary pace. Until the end of the century, 12% of all bird species, 25% of all mammals, and at least 32% of all amphibians are threatened with extinction. Yet, very little is known about the mechanisms that determine the sustainable level of biodiversity and the environmental implications of biodiversity loss. These difficulties are exacerbated by the broad range of time scales involved, covering days to millions of years, and the large numbers of species and interactions between them.

Over the coming years, IIASA's Evolution and Ecology Program (EEP) will be addressing these problems by combining modern evolutionary theory with recent insights into the structure and dynamics of ecological interaction networks. While classical speciation theory emphasized the importance of geographic isolation in triggering diversification, it is becoming increasingly clear that the competitive struggle within and between species plays a central role by shaping and reshaping the environmental challenges in response to which species evolve.

With direct observations or manipulations of biodiversity evolution rarely being feasible, innovative models are critical for advancing this research. The approach being developed by EEP will focus on universal properties of diverse ecosystems that apply independently of their particular species composition. Results will have an immediate bearing on the management of biodiversity loss at regional and global scales. ■

IIASA's Evolution and Ecology Program  
[www.iiasa.ac.at/Research/EEP](http://www.iiasa.ac.at/Research/EEP)



## FRAGILE INFRASTRUCTURE

# Turn out the lights, the party's over

On the fragility of infrastructures  
crucial for modern life

**T**he headline in the 31 January 2008 *International Herald Tribune* pronounces "South Africa Fumes Over

Power Outages." The story goes on

to say that the South African government confessed to an "electrical emergency" and has begun a program of rationing power for industrial users. We're used to temporary power outages, often on a regional basis, as past events in the northeast corridor of the USA have repeatedly shown. What's so special, then, about the South African situation?

What makes the situation in South Africa "interesting" is that it is not simply a short-term failure of some transformer at a substation or the downing of a power line somewhere whose effect percolates through the system. Rather, it is a total *systemic* failure of an infrastructure critical for the economic, social, and financial health of the entire country. The problem is a lack of planning and foresight in anticipating the electrical power needs of the country, and a consequent failure to build the necessary capacity into the system. This is a *prima facie* example of how fragile infrastructures can be and the dramatic implications of their failure for modern life.

Another example, but of a different qualitative character, took place when truckers went on strike in Italy in December 2007. Trucks blocked key roads across the entire country, preventing delivery of materials vital for everyday life, such as food, gasoline, and medical supplies. "This is not good. They have no fruit, vegetables or milk," said one shopper in downtown Rome, viewing the empty shelves in the store. Gasoline stations across the country ran dry within two days of the strike's beginning.

These sorts of examples involving other infrastructures like the Internet, financial markets, and air-traffic control systems can be multiplied almost indefinitely, underscoring the need to develop tools for understanding the strange ways of networks and how to keep them functioning in the face of unknown, and probably unknowable, disturbances and disruptions.

## The connections that count

Virtually all infrastructures consist of "something" (people, money, goods, information, energy...) that's available somewhere and must be transported to somewhere else. So problems of infrastructure analysis are, in essence, *generalized transportation problems*, to use the terminology of the operations research world. Conceptually,



then, an infrastructure network consists of a set of *nodes*, which are producers and consumers, along with a collection of *links* by which the "something" of the infrastructure is conveyed from the producers to the consumers. At the most primitive level, there is a link between two nodes if a direct connection exists in the network between the producer and the consumer represented by the two nodes. Experts will realize that this is a cartoon image of a real infrastructure; nevertheless, even at this simplified and abstract level we can learn a lot about how robust such a network is to things like the removal of a node, cutting of a link, or reducing the flow capacity along certain connections.



**INFRASTRUCTURES INTEGRAL TO OUR MODERN LIFESTYLES** This airline route network



The initial theoretical work on such networks focused on structures in which links were added at random. The central question then became: What probability of adding a link between two nodes gives rise to a kind of “phase transition,” where the network becomes strongly connected so that every node is accessible to any other via some sequence of links. Strangely, it was only about ten years ago that researchers realized that real-world networks don’t have this structure at all.

Real networks do not have links that appear independently, “at random.” Rather, there is an historical process at work by which the likelihood of a link being added is determined by the links already existing in the network.

The mathematical consequence of this observation has given rise to an enormous literature on so-called “Small Worlds” networks, in which one can move from any node in the network to any other in the famous “six degrees of separation” pattern made famous in both literature and science and whereby any two people on the planet are connected, on the average, by only six links (i.e., common acquaintances). Even more importantly for the study of infrastructures, it was also discovered about the same time that almost every real-

world network, ranging from the Internet to biochemical reactions in living organisms, forms what’s now called a *scale-free network*.

A scale-free network is one in which a few nodes have a huge number of links, while the overwhelming majority of nodes have only a few. A good example is the air-travel network, in which a few airports, the so-called “hubs”—like Heathrow in London, Hartsfield-Jackson in Atlanta, or Suvarnabhumi in Bangkok—have a large number of flights to/from many places, while most of the airports, the “feeders,” have very few.

In retrospect, it’s plain to see why both humans and nature prefer scale-free infrastructures, since they are, in general, rather impervious to minor disruptions at different parts of the net. If you remove a node or a link at random, the chances are very high that it will have no noticeable effect on the performance of the network, since the element removed will almost surely be one that’s weakly

connected to the rest of the system. So if you want to disrupt the air-travel infrastructure, don’t focus your energies on taking out Peoria, Perth, or Panama City. You’ll get a much better return on your “investment” by knocking out O’Hare, Narita, or JFK. Much is now known about the structure of such infrastructure networks, at least in the case when the system is not changing. But many very practical and theoretical questions remain.

### Really real infrastructures

The infrastructures of everyday life, such as the South African power grid or the international air-traffic system, are certainly not static; they’re changing all the time, in both planned and unplanned ways. Moreover, infrastructures are coupled, and thus very far from being independent of one another. Some infrastructures, like the electric power grid, are simply more fundamental than others. And if we want to ensure some measure of reliability of an infrastructure in the face of various disturbances, we have to pay a price of some sort for that security. These factors lead to several much needed methodological extensions and generalizations to the static network analysis results of the past decade. The areas calling for attention include

- **Dynamics** How does the connective structure of the network affect the flow of materials in the system? This is basically a question of network flow analysis, for which many good techniques are available. But there is a second, higher-level sort of dynamic involving changes in the network itself. Nodes and links come and go, and they do so at the very same time that material is flowing through the system. At present, we have no sure-fire methods for understanding how to redirect traffic under such circumstances. So this type of dynamical behavior offers many new challenges to both methodologists and practitioners.
- **Hierarchies** How does the performance of one infrastructure impact that of another to which it is connected? What level and form of connections are needed to prevent a cascade of failures percolating from one infrastructure to another?
- **Resilience** How should we measure the trade-off between the economic efficiency of an infrastructure operation and the ability of the infrastructure to perform its functions when damaged in various ways? This is the “resilience versus efficiency” problem, about which rather little is known.
- **Infrastructure equivalence** Recent research by the ecologists R. May, S. Levin, and G. Sugihara suggests that ecological infrastructures and the world financial system share a number of common structures surrounding robustness and efficiency that should enable knowledge of one to shed light on the other. Systematic procedures for identifying such infrastructure “homologies” is currently absent.

### IIASA’s Fragility of Critical Infrastructures (FCI) initiative

Over the past year, IIASA’s Dynamic Systems (DYN) Program has launched an initiative for the development of methodology to attack some of the foregoing questions. As IIASA is an institute of *applied* systems analysis, the FCI initiative comprises both methodologists and applied researchers in a collaborative effort to unlock a few of the secrets of how modern networks function. In this regard, the FCI has also formed a Business Consortium in order to foster collaboration with the worldwide business and governmental communities. ■

**Further information** IIASA’s Fragility of Critical Infrastructures (FCI) initiative at [www.iiasa.ac.at/Research/FCI](http://www.iiasa.ac.at/Research/FCI) and a list of references at [www.iiasa.ac.at/Options/sources](http://www.iiasa.ac.at/Options/sources)

**Dr. John Casti** is a research scholar with IIASA’s Dynamic Systems Program.



is a typical example.

RESEARCH SUMMARIES

# IIASA Policy Briefs

A new series of publications

IIASA has launched a new series of publications, IIASA Policy Briefs, to help present the Institute's research findings to policymakers. IIASA Policy Briefs summarize some of the latest research from IIASA by highlighting the main findings and policy implications.

IIASA's goal is to provide science-based insight into critical policy issues in international and national debates on global change. Throughout its 36 years, the Institute's research has fulfilled this mission by greatly benefiting a wide range of countries. For example, IIASA's research into air pollution has helped reduce air pollution across Europe. And IIASA's researchers have played a key role in the world-renowned reports by the Intergovernmental Panel on Climate Change (IPCC).

**Further information** IIASA Policy Briefs are available online at [www.iiasa.ac.at/Publications/policy-briefs](http://www.iiasa.ac.at/Publications/policy-briefs)

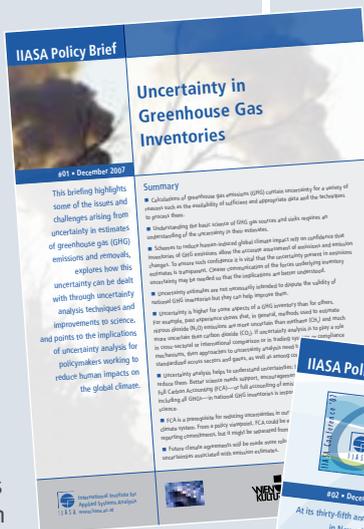
## Uncertainty in Greenhouse Gas Inventories

IIASA Policy Brief #01 ■ December 2007  
Forestry Research

This briefing highlights some of the issues and challenges arising from uncertainty in estimates of greenhouse gas (GHG) emissions and removals, explores how this uncertainty can be dealt with through uncertainty analysis techniques and improvements to science, and points to the implications of uncertainty analysis for policymakers working to reduce human impacts on the global climate.

Findings include:

- Schemes to reduce human-induced global climate impact rely on confidence that inventories of GHG emissions allow the accurate assessment of emissions and emission changes. To ensure such confidence, it is vital that the uncertainty present in emissions estimates is transparent. Clearer communication of the forces underlying inventory uncertainty may be needed so that the implications are better understood.
- Uncertainty is higher for some aspects of a GHG inventory than for others. For example, past experience shows that, in general, methods used to estimate nitrous oxide (N<sub>2</sub>O) emissions are more uncertain than methane (CH<sub>4</sub>) and much more uncertain than carbon dioxide (CO<sub>2</sub>). If uncertainty analysis is to play a role in cross-sectoral or international comparison, or in trading systems or compliance mechanisms, then approaches to uncertainty analysis need to be robust and standardized across sectors and gases, as well as among countries.



## Global Development: Science and Policies for the Future

IIASA Policy Brief #02 ■ December 2007  
IIASA Conference '07

At its thirty-fifth anniversary conference in November 2007, IIASA brought together a star-studded cast of scientists, policymakers, and thinkers to discuss Global Development: Science and Policies for the Future. The aim was a wide-ranging discussion of what a sustainable and equitable future might look like, and how to get there. Foremost in everybody's minds were research priorities and how an interdisciplinary institution dedicated to systems analysis on a global scale might contribute.

Key points include:

- The world faces two fundamental challenges in the twenty-first century. One is to root out the persistent and entrenched poverty of the "bottom billion" of humanity. The other is to prevent economic growth from overwhelming the global commons—the atmosphere, oceans, water cycle, and biodiversity.
- But there was disagreement about whether these goals can best be secured through better management of the existing political and economic systems, or whether more fundamental changes were needed. Put simply, can continued economic growth be made sustainable or not?
- There was antipathy between the two sides on this. Those who favored fixing the existing system accused those demanding fundamental change of diverting the world's attention from practical solutions. They in turn accused the fixers of ignoring fundamental problems, particularly of over-consumption.
- More positively, there was discussion of potential no-regrets solutions that addressed both social and environmental problems. Finding alternatives to burning fossil fuels, for instance, addressed human health problems from smog and climate change. And the benefits of good governance in solving problems were illustrated.



## FINANCIAL RISK MANAGEMENT

# Preparing Madagascar for cyclones

## Reducing the impact of natural disasters on the Malagasy economy

Cyclones are the most common natural disasters to strike Madagascar. The immediate cost of helping victims and repairing critical infrastructure is often huge. Such costs can swamp the ability of governments in low-income countries like Madagascar to finance the recovery process.

In 2004, cyclone Gafilo—the most intense cyclone ever to form in the South Western Indian Ocean—struck Madagascar, killing at least 363 people, destroying the homes of 200,000, and causing damage worth more than 5 percent of the island's GDP. On average, two cyclones hit Madagascar every three years, meaning government finances barely have a chance to recover between natural disasters. Further, it is feared that climate change will exacerbate the number and impact of natural disasters.

Not surprisingly, many low-income countries rely on post-disaster assistance such as international humanitarian donations to meet the reconstruction costs. But disaster aid is often too little and too late. Without sufficient post-disaster funds to repair critical infrastructure and assist victims, the follow-on indirect losses can be extensive. For example, five years after the devastation of Hurricane Mitch in 1998, the gross domestic product of Honduras—another very disaster-prone and vulnerable country—was 6 percent below pre-disaster projections. Donor pledges of US\$2.7 billion were considered exceptionally high but amounted to only about half the estimated reconstruction costs.

Yet, natural disasters are not natural at all and their impacts are determined by the interplay of the natural hazard and an exposed and vulnerable society. Impacts can be significantly decreased by prudent planning and catastrophe risk management.

In 2007, a team of IIASA researchers led by Dr. Reinhard Mechler and Dr. Stefan Hochrainer began working with the Government of Madagascar and key stakeholders to identify options to reduce the

country's risks to natural disasters. Currently, in Madagascar and elsewhere, natural disasters are usually dealt with after the fact and little is done to prevent losses or adapt to risks, despite the high number of natural hazards. The balance is shifting with improved modeling techniques and stakeholder-based, interactive planning tools.

The IIASA research team—through systematic modeling of natural hazard risk in Madagascar and its fiscal and economic consequences—is helping the government see how risk can be reduced, segmented, and absorbed domestically by public expenditure and internationally by donors. Further, a key issue addressed is what roles risk-sharing and transfer instruments such as reserve funds or insurance can play.

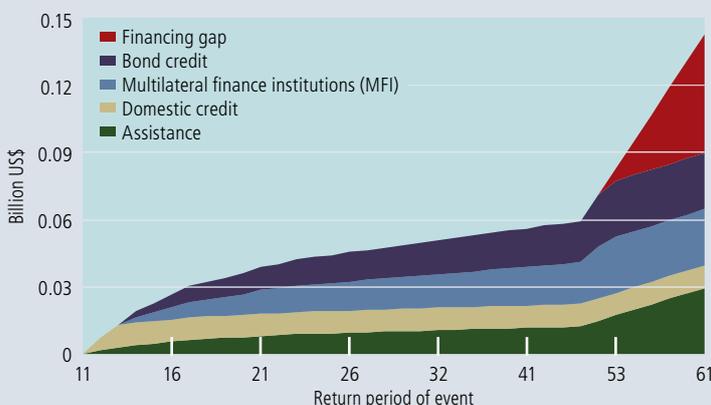
The analysis is based on IIASA's interactive catastrophe simulation model (CATSIM). The model helps a country assess its financial and economic vulnerability to extreme events and illustrate the trade-offs and choices a government must make to manage the economic risks due to natural disasters. This decision-support tool is made possible by its unique combination of the science of natural disasters (from meteorology to geography), catastrophe risk modeling, extreme value statistics, and the economics of natural disaster risk management.

Officials from the Malagasy government have been using CATSIM to explore the viability of different policies. In February 2007 at IIASA, delegates from Madagascar's finance ministry received in-depth training on the model. Options explored comprised setting up a national disaster reserve fund, which is now being discussed in the country's parliament, and a stand-by credit facility with a multilateral finance institution contingent on a severe disaster occurring. ■

**Further information** IIASA's Risk and Vulnerability Program at [www.iiasa.ac.at/Research/RAV](http://www.iiasa.ac.at/Research/RAV)

**Dr. Reinhard Mechler** and **Dr. Stefan Hochrainer** are research scholars in IIASA's Risk and Vulnerability Program.

**IDENTIFYING FINANCING NEEDS FOR MADAGASCAR** The red area demonstrates the financing gap the country could face for certain extreme events. Results from IIASA's CATSIM model.

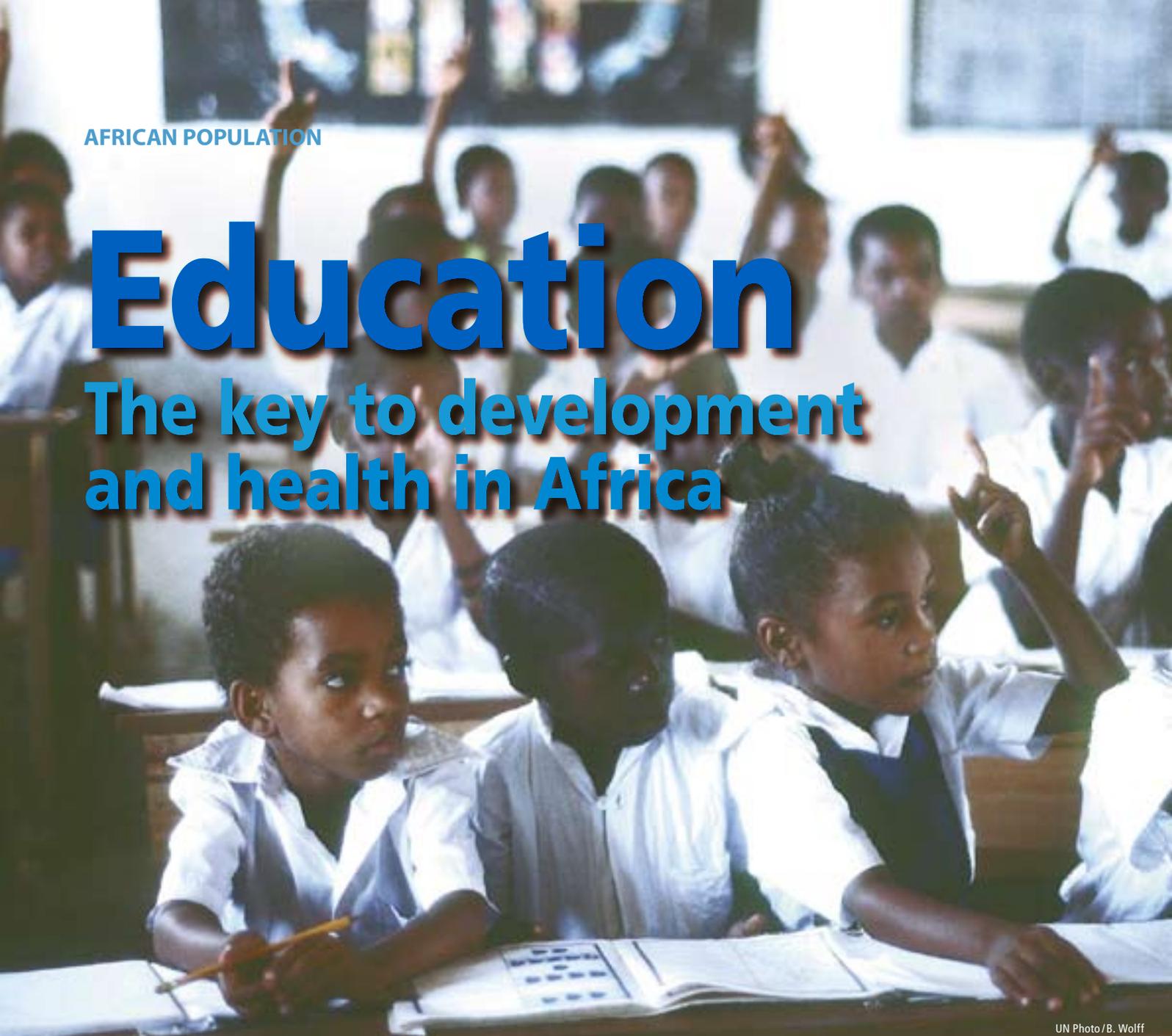


**TROPICAL CYCLONE GAFILO**  
located west-northwest of Antananarivo,  
Madagascar, 8 March 2004.



# Education

## The key to development and health in Africa



UN Photo/B. Wolff

**IIASA's World Population Program recently completed research which, for the first time, scientifically proves the key role of human capital formation in a country's economic development.**

**A**t the heart of the many problems faced by Sub-Saharan Africa are the intertwined challenges of rapid population growth and low human capital—human capital being defined here as people with a certain education and health status. The human drivers of development are made up of this interacting population–education–health triad in every world region. But in Africa, the interactions are particularly important in terms of bringing people out of poverty.

This short article will show that education is a fundamental determinant not only of health, demographic trends (in particular, fertility), and individual income, but also—and notably—of a country's aggregate level economic growth. It will show, too, that in order to provide the boost in economic growth that brings countries out of poverty, universal primary education needs to be supplemented by providing secondary education to a wide

proportion of the population. However, in many African countries, slow or even stalled fertility declines have resulted in very high population growth, which seriously curtails the increase in school enrollments. For that reason, family planning also needs to be among the development priorities in Africa.

### **The continuing "population explosion" in Africa**

The population of the Sub-Saharan subcontinent is expected to show the highest growth of any world region over the 21st century. Despite AIDS and many other health problems, the latest 2007 probabilistic projections by researchers from IIASA's World Population (POP) Program show a likely tripling of the population from 600 million in 2000 to around 1.5 billion in 2050 and 2 billion in 2100. However, as population growth will depend on the uncertain future courses of fertility and mortality, there is substantial uncertainty around this median projection. ▶

## EDUCATION AND ECONOMIC DEVELOPMENT What are the alternatives?

Using the demographic method of multi-state back projections, a group of researchers at IIASA and the Vienna Institute of Demography have recently completed a full reconstruction of educational attainment distributions by age and sex for 120 countries for the years 1970–2000. The advantages of this dataset relative to others are its detail (four educational categories for five-year age groups of men and women), its consideration of differential mortality, and its strict consistency in terms of the definition of educational categories over time. The age and education composition detail in our new data allow us to perform more detailed statistical analyses of the relationship between education and economic growth than can be performed using data that existed before.

Previous cross-country economic growth regressions tended to show that changes in educational attainment are largely unrelated to economic growth, which is in contradiction to theory and microeconomic evidence. Most of the literature in this field attributes the existence of this puzzle to deficiencies in the series of education data. Moreover, the fact that averaging education attainment data over longer horizons led to more consistent patterns points to the significance of measurement problems in the previous data.

Using our new educational attainment data by age groups, we estimated simple growth regressions based on five-year periods for a panel of 101 countries (with a fair representation of all continents) for which all the

necessary economic and education data exist over the period 1970–2000. These new data allow us, for the first time, to exploit the education levels of different age groups as potential determinants of economic growth. The results show consistently positive, statistically significant education effects (at any sensible significance level for secondary and tertiary education) on economic growth for some age/education groups. The results of this study have recently been published as a Policy Forum in *Science*.

The chart (left) illustrates the implications of the results for four cases that roughly resemble alternative hypothetical education policy strategies for a poor African country. The chart presents the average annual GDP growth rates corresponding to different education distributions.

**Scenario 1** presents the reference case of a country with a young age structure, a low starting level of income and investment rate, and the following educational structure: half of the population with no formal schooling, 40 percent with some primary, and 10 percent with at least completed junior secondary school (but no tertiary education). The education groups used in the analysis (no education, primary, secondary and tertiary) and referred to in Figure 2 on page 14 are non-overlapping. Based on the estimated model, such a country would have rather slow economic growth.

**Scenario 2** considers the otherwise identical country under the hypothetical assumptions that it has been meeting Millennium Development Goal (MDG) 2—“achieve universal primary education”—and the previously uneducated half of the adult population now has primary education. This case would lead to somewhat higher average growth of GDP.

**Scenario 3** considers a possible MDG+ that adds widespread secondary education (we assume here 50 percent of the population achieving at least some secondary schooling) to universal primary. The model simulations indicate that this additional investment in secondary education provides a huge boost to economic growth, over five times the level of the baseline case and also much more than in the case of universal primary education alone.

**Scenario 4** presents another possible direction of improvement from the baseline (which somewhat resembles the case of India) in which half of the population remains without education while 5 percent have tertiary education, 15 percent secondary, and 30 percent primary. This case of elitist education in a context where half the population is without schooling clearly does better than the baseline case and even better than the universal primary education (combined with 10 percent secondary and no tertiary); however, it falls far short of the economic growth implied by universal primary combined with 50 percent secondary and no tertiary education.

These new findings have great political implications for development policies and for the next round of defining international education goals. The current MDG focus on universal primary education is important but insufficient. It needs to be complemented with the goal of giving broad segments of the population at least a completed junior secondary education. Only this is likely to give initially poor countries the human capital boost that is necessary to bring large segments of the population out of poverty. For more industrialized countries, tertiary education of younger adults also plays a key role as a determinant of economic growth.

In conclusion, the message for Africa is: more and better education must be the top priority and must be placed above infrastructural and other investments. More education not only leads to better health and higher individual income but is also a necessary (although not always sufficient) precondition for long-term economic growth. Better female education, together with renewed family planning efforts, will also help to slow the rate of population growth which currently puts undue stress on existing infrastructure and natural resources. A concerted effort for much more primary and secondary education combining national and international forces seems to be the most promising route out of poverty and toward sustainable development in Africa. ■

**Further information** Lutz W, Crespo Cuaresma J, & Sanderson W (2008). The Demography of Educational Attainment and Economic Growth. *Science* 319(5866): 1047–1048. Available at [www.sciencemag.org](http://www.sciencemag.org).



ANNUAL GDP GROWTH RATES according to the four alternative educational attainment distributions



**KHOTSO MOKHELE**, former first president of the South African National Research Foundation, speaking at the IIASA Conference '07, vividly emphasized that now, more than ever before, Sub-Saharan Africa needs wisdom if it is ever to escape its low development trap. He also underlined the role of human capital formation in this process and the need for Africans to have access to careers upon which an economy can be built.

Figure 1, showing probabilistic population projections for Sub-Saharan Africa, illustrates that the 95 percent uncertainty range (*brown area*) goes from a “mere” doubling of Africa’s population to an increase by a factor of six before the end of this century. Evidence published in 2008 by the Population Council on the stalled fertility transition in a sizable proportion of the African population shows that the expected decline in fertility should not be taken for granted and needs urgent policy attention.

Today, two-thirds of the population of Sub-Saharan Africa are under 25 years of age and the average fertility rate is still above five children. Although the population still lives in predominantly rural areas, more and more people are migrating to the cities in what appears to be a vain attempt to escape poverty. Recent studies by the African Population and Health Research Center (APHRC), a partner of POP, in fact show that in some urban slum areas, health and living conditions have actually become worse than in remote rural areas.

### Education: The key to many doors

IIASA research shows that in Sub-Saharan Africa, education is the key policy variable that can reduce poverty, improve health, and help people move beyond the current state of emergency. Figure 2 illustrates this point for the case of fertility. The effect of education on fertility is shown for three African countries with a large population—Ethiopia, Kenya, and Nigeria—for selected years for which Demographic and Health Surveys (DHSs) are available. It can be seen that women with higher levels of educational attainment almost universally have fewer children than women with lower levels of education.

When the data are compared over time, a differentiated picture appears of the stalled fertility decline mentioned above. For well-educated women, fertility clearly declines (except in Nigeria after 1999), whereas for less-educated women, fertility actually shows increases since the late 1990s. This difference in trends is most remarkable in Ethiopia. Between 2000 and 2005, the difference between the highest and lowest education groups increases from 2.7 to 4.1 children per woman, a rise that is mainly due to the rapid decrease in childbearing among well-educated women. This interesting pattern supports the view that without strong government-supported family planning programs, fertility declines only where population groups have passed a certain

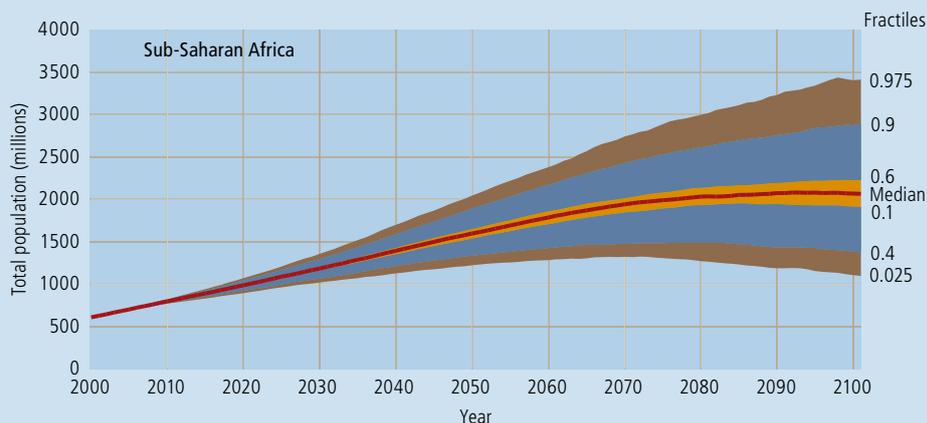


FIGURE 1 Probabilistic population projections for Sub-Saharan Africa.

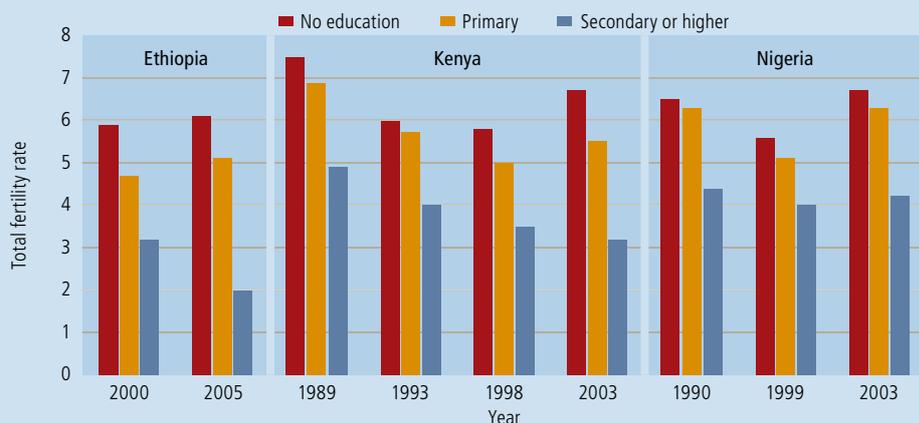


FIGURE 2 Total fertility rates by level of educational attainment. (Source: Several DHSs)

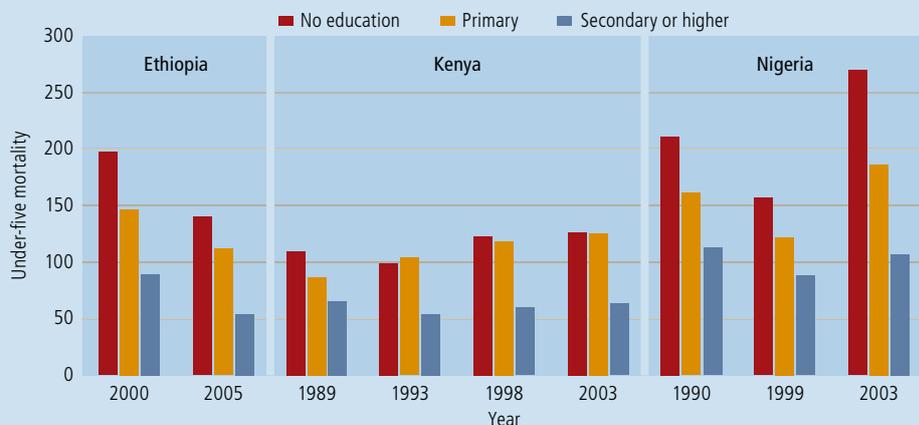
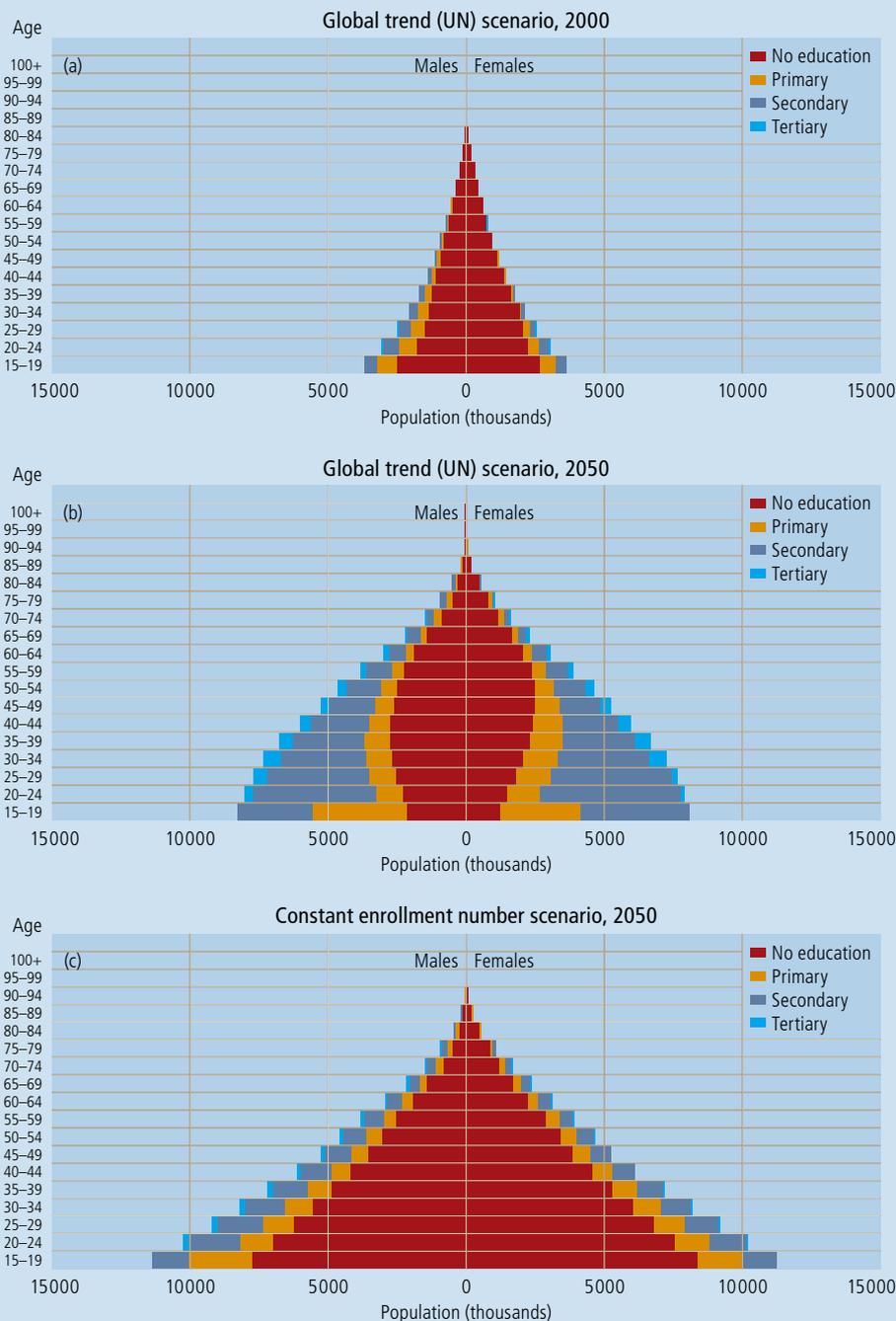


FIGURE 3 Under-five mortality by level of educational attainment of mothers. (Source: Several DHSs)

developmental threshold that makes them desire fewer children and, in return, better opportunities for those they have (“quantity” versus “quality” trade-off). And education seems to be the key factor in this process.

But better education also results in better health for mothers and children because of better access to crucial information and health care. In Ethiopia, women with at least some secondary education are 260 percent more likely to receive antenatal care than women with no education. In Kenya and Nigeria, these differences are 34 percent and 133 percent, respectively.

These factors also result in huge educational differentials in child mortality. Figure 3 shows the mortality rate of children under five by educational level of their mothers. While the effect of some primary education (of mothers) on child mortality is significant in Ethiopia and Nigeria but not in Kenya, the effect of secondary education is significant everywhere. Based on the latest observation, the overall situation in Nigeria has significantly worsened, with 27 percent of children born to mothers without education dying before their fifth birthday; in Kenya and Ethiopia the numbers are 12 and 14 percent, respectively.



**FIGURE 4** Ethiopia: Population by age, sex, and educational attainment.

For women with secondary or higher education, the level of child mortality is less than half of that. This great health advantage of being more educated also holds for adults, as POP has shown in other studies.

### The population dynamics of improving human capital

The methods of multi-state population projections which were developed at IIASA during the 1970s turn out to be ideal tools for modeling the past and future trends of the changing educational composition of the population. As we will show in the

case of Ethiopia, this is particularly relevant for Africa. As Figure 4a illustrates, the majority of the adult population of Ethiopia (over the age of 15) have never been to school (*red area*). The age pyramid also shows that for the younger adult population, the proportions with primary and secondary education have been increasing visibly. The much cruder human capital variable “mean years of schooling of the entire population above age 15,” most often used by economists, hides these age-specific patterns which turn out to be so important for assessing the returns to education.

Figures 4b and 4c present the results of education-specific population projections based on two alternative scenarios regarding the future education trends in Ethiopia. The first scenario (Figure 4b) assumes that: (1) future increases in school enrollment rates will follow the global trend of improvements that was observed for other countries in the world over the past decades; and (2) education-specific fertility trends are such that they resemble the overall population trends as projected by the United Nations for Ethiopia. This results in a very positive development for a country in which—by the middle of the century—the majority of the younger population will have at least some secondary education. As shown in the box on page 13, this is also likely to boost economic growth.

The alternative scenario (Figure 4c) (1) assumes that the schooling system of Ethiopia is not developed any further and the absolute number of students attending schools every year remains at its current level and (2) applies identical education-specific fertility trends as in the first scenario. Because of past improvements in the education of the younger segment of the population, the average education in 2050 under this scenario will still be somewhat better than today, but in many respects the picture looks much worse than under the first scenario, giving the picture of a rapidly growing, mostly uneducated population, trapped in poverty. A very interesting aspect is the fact that even the assumption of identical education-specific fertility rates in both scenarios yields such widely differing patterns of overall population growth. The age pyramid in Figure 4c is much broader at the bottom than the one in Figure 4b simply because less-educated women have more children and under the second scenario there will be many more less-educated women. This vividly illustrates a major developmental trap: if the school system does not expand, then high fertility of the uneducated will mean an increasing number of children, which will result in a declining proportion of children going to school; this, in turn, will result in more uneducated women who again will have higher fertility. Only combined efforts in education and family planning services can help to break this vicious circle. ■

**Further information** IIASA’s World Population Program at [www.iiasa.ac.at/Research/POP](http://www.iiasa.ac.at/Research/POP)

**Professor Wolfgang Lutz** is the leader of IIASA’s World Population Program. **Dr. Anne Goujon** and **Mr Samir KC** are research scholars in IIASA’s World Population Program.

# Climate change and agriculture in Africa

Climate change poses serious threats to food production in Sub-Saharan Africa and risks further impoverishing many of the world's poorest countries. IIASA's research addresses the food security and climate change challenges for this region.

Food prices are rising alarmingly. The World Bank estimates that over the past three years, food prices overall have risen 83%. Some of the rising prices can be attributed to poor weather conditions and extreme weather events that have resulted in lower harvests in a number of countries. At the same time, rapidly increasing demand—especially for livestock feed from fast-growing Asian economies and for ethanol production in developed countries—has aggravated the mismatch between global supply and demand. World food stocks are at their lowest level in three decades and major food exporting countries have adopted measures to protect domestic markets. Food import bills in many of the poorest developing countries have doubled.

Rising food prices have a far more devastating impact on people in the developing world where often more than 70% of the household budget is for food, compared to 15% of people's expenditure in developed countries. Already an estimated extra 100 million people have recently joined the 820 million chronically undernourished and hungry in the developing world. The situation in Sub-Saharan Africa (SSA) is particularly dire. About 40% of the total population in SSA is undernourished, of which about 85% depends on rain-fed agriculture and agriculture-based rural activities. Agriculture is the mainstay of the economies of many SSA countries, accounting for 30% of GDP and even half of total export earnings.

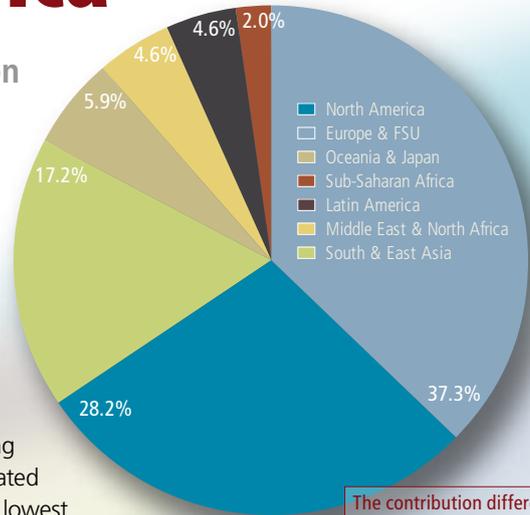
Climate change poses serious threats to food production, and SSA is the most exposed to the negative impacts of climate change. Yet SSA has contributed very little to the causes of climate change—a mere 2% of the world's aggregate anthropogenic CO<sub>2</sub> emissions over the last 50 years, whereas developed countries have contributed over 70% (diagram, top left).

Ongoing research in IIASA's Land Use Change and Agriculture (LUC) Program addresses the food security and climate change challenges in the 21st century. Based on the IIASA-FAO spatial global agro-ecology model and the national and regional world food economy modeling framework, the major findings for SSA are summarized below.

**FRAGILE ECOSYSTEMS** Two-thirds of the global land surface suffers rather severe constraints for rain-fed crop cultivation due to unfavorable weather conditions, steep topography, or poor soil quality. Climate change will have positive and negative impacts, as some constraints will be alleviated while others may increase.

Southern Africa is among the most severely affected regions with some 11% of the land at risk of being lost for crop agriculture due to climate change induced environmental constraints. Our research estimates an increase of areas with severe dry conditions in SSA by about 5–8%, or 60–90 million hectares in the 2080s (diagram, top right).

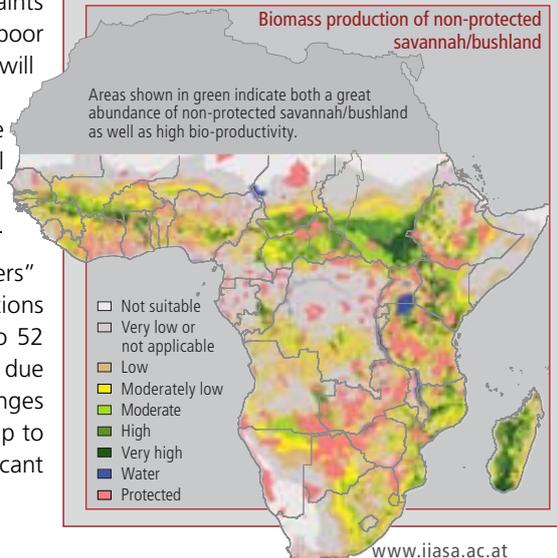
**UNDERNOURISHMENT** There is a clear distinction between the "gainers" and the "losers" of the impact of climate change on agriculture production. In the case of projections using HadCM3—the UK Hadley Centre's global climate model—globally some 27 to 52 countries will lose cereal production potential while some 42 to 59 countries will gain due to projected climate change in the second half of this century. The net balance of changes in cereal-production potential for SSA is projected to be negative, with net losses of up to 12%. Overall we estimate that more than a third of SSA countries is at risk of significant declines in food crop and pasture production due to climate change.

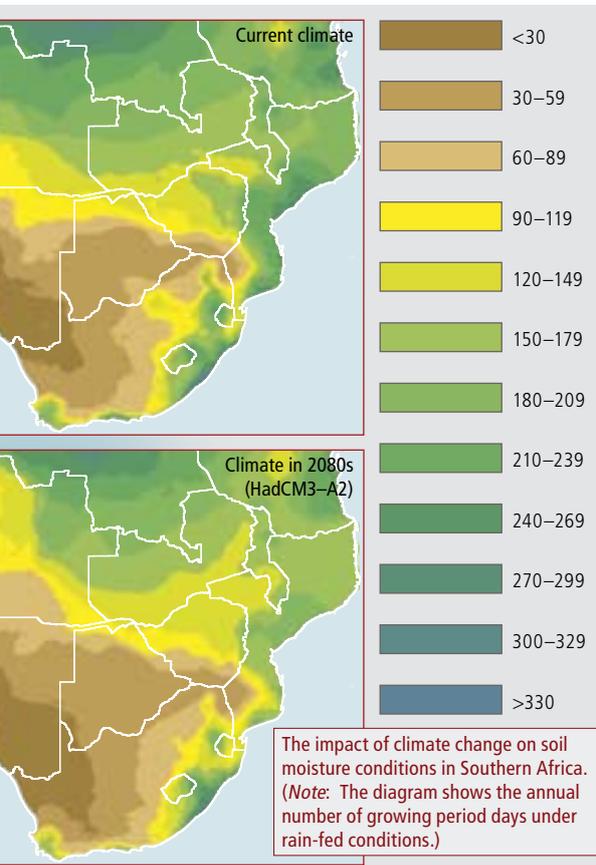


The contribution different regions have made to carbon dioxide emissions between 1951 and 2004.

## Is there enough land for food and energy in Sub-Saharan Africa?

In Africa, less than 9% of the total land area of 3 billion hectares is currently used for crop production. Of the remaining 91%, about 45% is covered by water bodies, desert, steeply sloped, and otherwise unproductive land. Pastures, savannah, and bush covers 22%, about 18% is under forest, 6% is protected non-forest land, and less than 1% is urban and built-up areas. Pastures, savannah, and bush—in total about 650 million hectares—is from environmental and agricultural perspectives most suitable for conversion to cropland, although it covers a wide range of bio-productivity (map, bottom). We estimate that about half of the annual biomass produced in these areas is currently needed to support ruminant livestock. Up to one third of this savannah and bush, some 200 million hectares, could be used for expansion of food and possibly energy production. Yet, the key to enhancing food security will be achieving sustainable yield increases on current cultivated land.





The burden will undoubtedly fall disproportionately on the poorest and the most vulnerable. Climate change in the second half of this century could result in an additional 17 to 50 million undernourished people in SSA.

The Millennium Development Goal's target of reducing hunger by half is highly unlikely to be met in SSA. On the contrary, by 2080 between 25% and 50% of the additional number of undernourished due to climate change in developing countries could be in SSA.

**AGRICULTURAL GDP AND TRADE** The impact of climate change on agricultural GDP is relatively small for the aggregate global level (between -1.5% and +2.6%). However, large variations are expected between regions. Developing regions, with the exception of Latin America, are confronted with strong negative impacts on agricultural GDP. By 2080, climate change could reduce Asia's projected agricultural GDP by 4% and SSA's by up to 8%.

Baseline scenarios indicate a growing dependence of developing countries on net cereal imports ranging from 170 to 430 million tons. In a number of developing countries, some 10% to 40% of cereal consumption will have to be met through imports. Many of these countries lack the foreign exchange to finance food imports, thus putting them at risk of increased food insecurity.

**MITIGATION OF CLIMATE CHANGE** At the same time as climate change reduces the availability of agricultural land, strong population increases and income growth will cause increasing food crop and meat demand. Unless sustainable yield increases materialize, this will intensify the pressure to deforest and clear land to expand crop and livestock production, in turn resulting in further greenhouse gas emissions. Additional emissions from agriculture in part will be unavoidable in SSA to meet the basic human right for food. Yet for another part, reductions could be achieved through, for instance, precision agriculture that ensures efficient use of fertilizers or the rehabilitation of degraded crop and pasture land. Specific efforts are required to mobilize funds to provide incentives for climate change mitigation activities, especially in agricultural areas across SSA.

**ADAPTATION TO CLIMATE CHANGE** To facilitate adaptation to climate change, national governments in SSA, together with their bilateral and multilateral development partners, need to create mechanisms that provide climate information and forecasting as well as strengthen scientific research and policy analysis at the national and regional levels. Due to the long time lag between the development of adaptation strategies and technologies and their adoption in the field, investments and sustained international funding will be needed to establish and prioritize agricultural research, agricultural knowledge systems, applied climate research for policy actions, and, in particular, agricultural extension, infrastructure, and marketing services.

**A WAKE-UP CALL** Many of the poor SSA countries, already struggling to cope because of low and declining agricultural yields, will be particularly affected by climate change. The World Bank, UN, and many governments and international organizations are now calling for additional emergency aid of at least US\$500 million from donor governments to close the immediate gap. In the long term, however, international effort is needed to coordinate policies to integrate climate change issues in national and international development planning and policymaking to achieve food security and reduce rural poverty.

The current food crisis is a loud wake-up call for national governments and the international community. Agriculture and the rural sector must be given a high priority in terms of resource allocation and adoption of development policies that are locally relevant and globally consistent. Such effective policies can only be devised if developing countries, assisted by international organizations and NGOs, thoroughly assess the impact of climate change on their own economies and natural resources. Only then can agricultural vulnerability to climate change be reduced and progress made to world-wide food security and sustainable agriculture (see box, "The way forward"). ■

**Further information** Shah M, Fischer G, & van Velthuisen H (2008). Food Security and Sustainable Agriculture. Presented at a side event at the UN Commission on Sustainable Development in New York on 8 May 2008. ([www.iiasa.ac.at/Research/LUC](http://www.iiasa.ac.at/Research/LUC))

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### The way forward in Sub-Saharan Africa

Progress in SSA agriculture has been hampered for multiple reasons over the past decades, and future prospects of more frequent droughts due to climate change add to a gloomy outlook. SSA can master its formidable development tasks, provided several contributing bottlenecks are tackled in a coordinated and simultaneous approach by the governments concerned with scientific, technological, and financial support from international organizations. The main cornerstones of a development strategy in SSA must include:

- Infrastructure expansion and improvements to enable crop production and agricultural inputs distribution
- Increased input use, e.g. ensuring that fertilizer use is affordable and available to farmers (currently some 5 kg/ha as compared to 92 kg/ha worldwide)
- Increased water conservation management and irrigation development (currently only 2% of SSA arable land is irrigated)
- Improved agricultural extension services to achieve sustainable yield gains, as current yields of main food crops are less than half compared to globally-achieved yields
- Expansion of agricultural R&D capacity and efforts to focus on region-specific adaptation and development needs
- Creation of production and marketing incentives to guide and foster investment decisions in agriculture

Developed countries will have to make important contributions as well, implementing policies that:

- Achieve substantial GHG reductions, especially in North America, Europe and Asia, to effectively mitigate speed and magnitude of climate change
- Prioritize resources to facilitate adaptation and promote development in SSA
- Avoid policy measures that accentuate market imbalances and put the resulting burden of high commodity prices on poor, import-dependent economies
- Coordinate biofuel policies according to a "food first" approach by supporting modes and means of bio-energy production that are GHG effective and minimize land competition
- Monitor, review and redefine policies for strategic food commodity reserves

Agriculture in SSA has been, and is frequently, severely disrupted through civil conflicts and poor governance. Illiteracy is high and prospects for improvement will also heavily depend on the development of human capital. ■

## GLOBAL ENERGY ASSESSMENT

# Making Energy Poverty history in Africa

Developing countries face many challenges regarding energy-related issues. In Africa, lack of access to affordable, reliable, sustainable energy sources continues to have disastrous health and social consequences for the poor—particularly women and children. Often, tackling the energy poverty issue represents a prerequisite to pursuing broader development goals. However, current patterns of energy system development are not environmentally sustainable, and the challenge of increasing access to energy services, while taking environmental constraints into account, is colossal. Moreover, because of soaring energy demands in developing countries due to economic development and population growth, a significant expansion of the energy infrastructure will be required.

It is estimated that about two-thirds of Africa's population (around 600 million people) rely on traditional biomass energy sources such as fuelwood, charcoal, agricultural waste, and animal dung to meet their daily cooking and heating needs. The use of these energy sources can be detrimental to both human emancipation and the environment. Indeed, indoor pollution from poor combustion in cooking stoves is responsible for approximately as many deaths annually as malaria or tuberculosis. As basic energy requirements are vital to sustain life and cannot be reduced, the absence of alternative energy sources is particularly problematic.

Within poor African communities, much time and physical energy is devoted to basic subsistence activities, including collecting fuelwood. This clearly increases marginalization and limits people's ability to improve their living conditions. Harvesting fuelwood unsustainably also contributes to deforestation, which not only harms the environment but increases the distance people have to go to collect fuel and decreases the associated services provided by the forest, such as food provision.

**POOR SPEND DISPROPORTIONATELY ON ENERGY** In terms of energy affordability, the share of household spending for energy is disproportionately high in poor African families. Absolute energy spending usually rises with income, but generally at a less than proportional rate. Typically, the energy expenditure in an industrialized country such as the United Kingdom represents on average 2 percent of household income in a relatively wealthy context and up to 6 percent in poorer families. In Sub-Saharan African countries, however, the share of indispensable energy services can exceed 15 percent of a typical household budget—with the poorest people frequently compromising on or even giving up key energy services like lighting and space heating.

**ENERGY AND THE MDGs** Access to modern forms of energy is crucial for achieving the Millennium Development Goals (MDGs). None of the goals is energy-specific; however, energy contributes, directly or indirectly, to the fulfillment of most MDGs. Energy not only sustains life, but is also key to integrated development, with both economic and social development being enhanced through the productive use of energy services. The case is often made that a target of 50 percent of the world's population benefiting from access to electricity would be in line with the MDGs. Access to energy services is a necessary, but not sufficient, element to alleviate poverty. Empirical evidence shows that a more comprehensive approach, focusing on productive uses of energy and income generation, generally generates greater socioeconomic benefits. ▶

**SEEING THE LIGHT** The challenges to be tackled in Africa to provide energy services to the poor are greatest in Sub-Saharan Africa. The lack of widespread access to modern energy is illustrated, to some degree, by the image of lights on Earth (*opposite*). The contrast between Africa and developed countries, like Western Europe and the USA, is striking. Other regions, such as India, Brazil, and Eastern Europe, seem to show much better access to electricity than Africa, with the notable exceptions of regions in South Africa, along the Nile, the northern Maghreb, and coastal zones of West Africa.

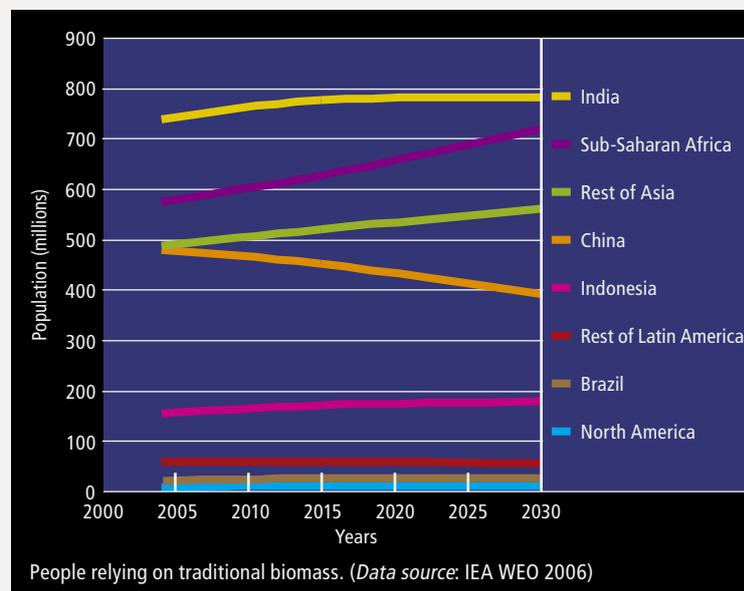
**POVERTY AND PLENTY** Broadly, the current primary energy map in Africa features North Africa relying on oil and gas, South Africa mainly on coal, and Sub-Saharan Africa largely on biomass, even in oil-rich countries. The energy issue in Africa does not seem to be primarily one of resource scarcity, and is sometimes referred to as the paradox of “poverty in the midst of plenty.” Africa is endowed with abundant resources of uranium, oil, gas, and coal. There is also a significant untapped renewable energy potential, notably hydropower, and also solar and geothermal, with small off-grid renewable technologies offering a valuable alternative to grid-connected systems in remote rural contexts. In comparison to the available resources, the current total energy requirement in Africa is minute. Yet, most of those valuable resources are exploited for export. Thus, one of the most urgent challenges is to generate value from those resources to benefit Africans, and especially the most in need.

A significant effort has been put into promoting access to modern energy services. Noteworthy success stories include the LPG program in Senegal and electrification in rural South Africa. Despite notable progress in relative terms, projections reveal an absolute increase in the number of people relying on traditional biomass in the world, with the highest rate of increase in Sub-Saharan Africa (chart, *right*). Other drivers, such as population growth, currently more than counterbalance the efforts deployed into providing the poor with modern energy services. Moreover, economic development is not expected to be high enough to allow most underprivileged communities to switch away from unprocessed biomass energy sources. Domestic energy consumption is also expected to grow rapidly, putting additional strain on energy systems and possibly energy prices.

**UPSCALING INVESTMENTS** Access to electricity is expected to increase steadily in all world regions, reaching close to 100 percent in most developing countries, with the notable exceptions of South Asian and African regions. The share of the population currently benefiting from access to electricity in Africa is about 25 percent. Although projections for the future vary considerably, they agree that the share of the African population with access to electricity is not expected to exceed 50 percent within the next couple of decades without a major paradigm shift.

If widespread access is to be provided to affordable, reliable, modern energy services, then investments in infrastructure and technologies clearly need to be upscaled. A significant increase in domestic and external funding and the development of innovative policies such as, for instance, carbon finance, will be necessary. Mobilizing large-scale investments, however, is far from trivial. Not only could capital availability be an issue, but the political, institutional, and economic environment needs to be stable enough to reassure investors. Numerous energy access pilot schemes have demonstrated their ability to promote sustainable development at local level. Yet, only the removal of financial, institutional, and regulatory barriers and bottlenecks will allow the development benefit potential to unfold on a large scale.

Providing affordable, reliable energy services to hundreds of million of people in Africa also represents tremendous socioeconomic opportunities at local and regional levels. There is a role in the energy access market for local entrepreneurs, including microenterprises and local community-based organizations, as has been the case for years in the oil sector. Indeed, local private sector involvement is essential for the sustainability of the efforts, and is most beneficial at local level due to its decentralized character.



**GLOBAL ENERGY ASSESSMENT** The development of poor African countries should not mirror the environmentally damaging development path followed by most industrialized countries. At the same time, as these countries’ historical responsibility for global environmental change is negligible, environmental concerns should not hinder their aspirations for better living conditions. There are, however, win-win strategies that promote development in harmony with the principles of sustainable development. For example, technological advances allow for the leapfrogging of intermediate options in the transition to energy for sustainable development.

The issue of energy access in Africa and elsewhere is multi-faceted and best assessed using an integrated approach. The Global Energy Assessment (GEA), a major initiative launched by IIASA, aims to address energy-related matters comprehensively and in an integrated manner. It will feature an integrated appraisal of energy issues in the contemporary context by combining a scientific assessment with strategic and investment recommendations. Special attention will be paid to energy access issues in the developing world, and the GEA intends to shed light on what a fast-track pathway to make energy poverty history in Africa within the next few decades would look like. ■

**Further information** [www.GlobalEnergyAssessment.org](http://www.GlobalEnergyAssessment.org)

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# Transforming Africa's conflicts into nation-building projects

Protagonists must shift the  
use of power from mutual  
destruction to the joint  
design of political, social,  
and economic systems

At the end of 2006, African conflicts accounted for about 30 percent of the estimated 10 million refugees and 33 million “persons of concern” to the UN High Commissioner for Refugees worldwide, 80 percent of UN peacekeepers, and 60 percent of UN Security Council time. These conflicts are the expression of a bad mix of poverty, underdevelopment, predatory leadership elites, poorly managed ethnic tensions, leftover liberation movements and militias, and weak states unable to effectively broadcast power or deliver social services. Violent conflict mutates across Chad and Sudan, changing form and location even as the UN deploys 26,000 peacekeepers in Darfur. Ethiopian forces prop up a weak government in Somalia. In Kenya violence and a massive displacement of people followed disputed presidential elections. In the Democratic Republic of the Congo (DRC) a rebel militia until recently violently defied being integrated into a national army following the advent of democracy. In Zimbabwe, President Mugabe is trying to push through what many fear is a flawed election result. For many it appears a depressingly familiar and repetitive scenario—but is it?

Social and political systems evolve through periods of order and disorder. Conflict signals that the design of a system has lost fit with its environment, that the goals and power of system actors have changed and require new arrangements of accommodation. Systems too rigid or weak to accommodate the changing needs and interests of their various stakeholders may of course be destroyed in confrontation—history is replete with collapsed empires and states, violent struggles against repressive regimes, and genocidal drives to eliminate “problem groups.” Resilient systems (those that survive internal conflicts and external threats) are, on the other hand, adaptive rather than simply stable. Their actors are responsive to signals of emerging conflicts, using the energy generated to continuously redesign systems through negotiation and joint problem solving. Democracies may not guarantee liberal dreams of economic growth or equity, wise government, or minority protections, especially in their simple (electoral) or distorted (pseudo) forms, but they still offer the best prospect of adaptability and system resilience.

After 30 years of independence in which only two changes of government occurred through multiparty elections, and over 100 by means of a coup, Africa experienced a short sudden wave of democracy—by 1995 no *de jure* single party states remained on the continent. Analysts, however, doubted the depth and strength of these new democracies, perceiving a sophisticated continuation of “big man” politics and pointing to weaknesses in civil society, the absence of a free press, hostile economic and social conditions, and weak government infrastructures as major problems. And so it has been. Several beacons of African stability such as Ivory Coast, Kenya, and Zimbabwe have stumbled badly in recent years. Even within the “rainbow nation,” for all its strengths, South Africans wrestle through social and political tensions over economic development, infrastructure, social delivery, corruption, safety and security, and race relations.

There is room for disappointment, but not despair. Appalling violence drove the evolution of liberal democracy in the West over several thousand years. Indeed, the advent of nation states and democracy as a form of government are only recent (Figure 1).

Africa's conflicts can be seen, too, from a developmental perspective. In many countries conflicts of democratic design have supplanted those of liberation, opposition movements show greater resilience in their struggle for democratic participation, street protests inform "big man" leaders that ordinary people will not simply accept election results perceived to have been rigged, and civil society is generating resilient NGOs and church leaders who don't lie down under repression. The outcome of Kofi Annan's Kenyan mediation is one of democratic redesign, a deal that redistributes power between the president and parliament. In Zimbabwe the rise of an internal as well as external opposition may see a rough interim period, but offers some promise of a more democratic future. As a continent,

Nation building requires that quick "in and out" approaches to peacekeeping or peacemaking should give way to more coherent multitrack, multitiered interventions. In the DRC the peacekeeping operation (MONUC) was mandated not simply to stop the fighting but to create conditions for negotiations, a viable transitional government, free and fair elections, and then a consolidated democracy based on sustainable economic growth. A more activist peacekeeping role creates space for peacemaking beyond temporary deal making—through social and political pacting, protagonists shift the use of power from mutual destruction to joint design of political, social, and economic systems, first in the form of transitional governments and then in the formulation of systems of representative

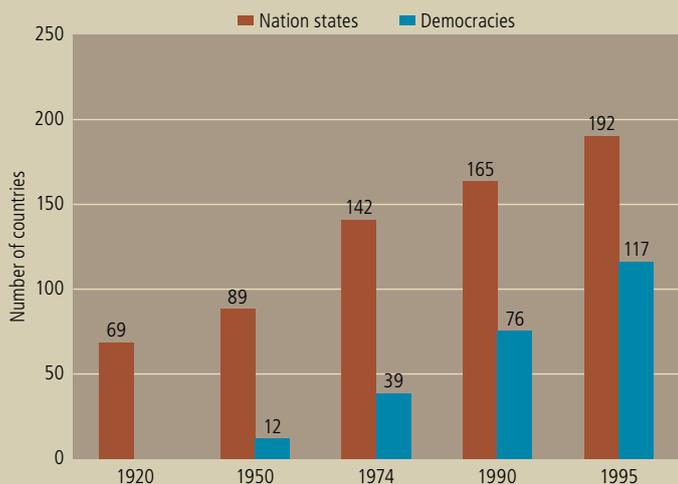


FIGURE 1 Nation states and democracies, 1920–1995.



FIGURE 2 Percent of Sub-Saharan nations rated as free by Freedom House, 1977–2007.

Africa is off the pace required to achieve the Millennium Development Goals, but many countries have made progress, several performing well enough to qualify for the Millennium Challenge Account grant program including Benin, Ghana, Lesotho, Madagascar, Malawi, Mali, Morocco, Mozambique, Senegal, and Tanzania. And Africa's economic growth rate has quickened to 5 percent per annum since 2000, and is projected by the UN Conference on Trade and Development and the International Monetary Fund to improve further. Its share of foreign direct investment (FDI) remains low at about 3 percent of the world FDI (US\$1.3 trillion) but there is increasing interest in its resources and investment potential, not least from China. FDI stock rose from US\$20 billion in the 1980s to US\$200 billion in 2006. FDI flows doubled between 2004 and 2006 to US\$36 billion largely into North Africa with a focus on oil, gas, and mining enterprises. Outward FDI also rose, driven by the expansionism of South African corporations.

So, yes, the misery of Africa's conflicts is unlikely to end soon. For those caught in the crossfire, displaced from homes and facing hunger and disease, the crisis is as fundamental in one conflict as another. Humanitarian interventions remain critically important. But a shift in vision is required. Africa's conflicts are largely intrastate rather than interstate. It is to the challenges of nation building that the energies of negotiators and third parties must be directed. The scope and complexity of the process which marked South Africa's negotiated transition to democracy is a benchmark, but successful negotiations have also occurred in the DRC, Mozambique, Senegal, and southern Sudan. The use of negotiation to resolve interstate tensions has also reflected some positive outcomes: in the Eritrea–Ethiopia conflict (after huge cost in life), in the DRC cease-fire, and in current tensions between Chad and Sudan. Botswana and Namibia agreed, too, to resolve a land dispute through the international courts rather than by violent means.

government and electoral systems. In addition, roundtables must attend to issues of safety and security, the creation of integrated police services and military forces, processes of transitional justice, economic policy and issues of investment, aid, debt and loans, the design and funding of infrastructure and sourcing of revenues. Meaningful assistance is long-term and expensive, directed at minimizing preventable conflicts, creating viable systems to regulate and manage unavoidable conflicts, and ratcheting up potentials for long-term sustainable economic development to take the edge off conflicts over scarce resources and needs to mobilize around ethnic markers. Interventions in Africa require long-term nation-building vision, directed at sustainable economies and a steady strengthening of democratic institutions (Figure 2).

Finding and resourcing credible mediators, acquiring region-specific information, developing a common vision of nation building, coordinating the efforts of multiple well-meaning agencies competing for relevance, and managing multiparty processes along many concurrent tracks of intervention makes modern third-party interventions a complex process. If mediators in their many forms are to assist protagonists in African conflicts to design systems for nation building, a long-term vision is required and some reevaluation of methods. Mediation is a process conducted "with" rather than "on" people; it is intended to help people use negotiation as the alternative of choice to resolve differences. Traditional African systems of consultation offer a foundation on which to build the "culture of negotiation" that marks viable democracies. ■

**Further information** IIASA's Processes of International Negotiation (PIN) Network at [www.iiasa.ac.at/Research/PIN](http://www.iiasa.ac.at/Research/PIN)

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On 27 June 2007 the U.S. Millennium Challenge Corporation (MCC) Board of Directors approved a poverty reduction grant for Lesotho for US\$362.6 million, of which US\$122.4 million supports a health sector project designed to mitigate the negative economic impacts of poor maternal health, HIV/AIDS, tuberculosis (TB), and other diseases by substantially strengthening the country's health care infrastructure. In preparation for that grant, MCC asked Landis MacKellar and William McGreevey of IIASA's Health and Global Change (HGC) Program to lead an analysis of the prospective costs and benefits of implementing the health component.

Based on engineering studies by another team of consultants, HGC estimated the capital costs of the proposed infrastructure improvements over the period 2010–2019. We also estimated the additional recurrent costs that would be incurred by the Ministry of Health to staff upgraded clinics and purchase drugs and supplies. Lesotho has an adult HIV+ rate of 25 percent, and a key assumption was that relieving infrastructure constraints would permit an expansion in HIV/AIDS treatment from 20 percent of the population in need to 80 percent. According to Clinton Foundation sources in Lesotho, US\$300 per year is a reasonable estimate of the cost of providing anti-retroviral therapy (ART) treatment to a patient. The Clinton Foundation is currently able to provide anti-retroviral (ARV) drugs at a cost of US\$150 per year per patient; adding another US\$150 takes generously into account other costs such as voluntary counseling and testing (VCT), periodic testing of monitoring of patients on ARVs, etc.

Based on the number of persons currently seropositive and on assumptions regarding the proportion of these who will become immunosuppressed each year and their life expectancy with and without treatment, the additional number of life years lived between 2010 and 2019 with expansion in treatment was estimated at 500,000.

Estimates were also made of the number of life years gained in 2010–2019 from expanded Prevention of Mother to Child Transmission (PMTCT) coverage and improved maternal and infant health. Sentinel surveillance suggests that about 30 percent of pregnant women in Lesotho are HIV+. In the absence of a comprehensive PMTCT program, about 35 percent of the babies born to these women will become HIV+ either during pregnancy, childbirth,

or breastfeeding. A PMTCT program can reduce this 35 percent risk by three-quarters. Yet, current PMTCT coverage of pregnant women in Lesotho is estimated to be only 15 percent. Making reasonable assumptions on the number of births over the 2010–2019 interval, and assuming that PMTCT coverage were to rise to 80 percent, we estimated that about 25,000 HIV+ births could be averted. Assuming that births are evenly distributed over the 2010–2019 interval and in the absence of competing hazards (i.e., that babies "saved" do not die of other causes), this would add perhaps another 90,000 life years lived between 2010 and 2019.

According to the Lesotho Demographic and Health Survey (DHS), only about half of births in Lesotho occur in a medical facility, and only a few more than that are attended by a medical professional. The DHS does not contain data on the causes of maternal mortality, but experts interviewed pointed out that close to one-third of maternal deaths are caused by sepsis, which in turn can be blamed on lack of soap and water. Many of the remainder are caused by maternal hemorrhage, which can be prevented in a reasonably equipped health center or dealt with by speedy referral to a district hospital. Based on these considerations, it was estimated that the MCC project could

## PUBLIC HEALTH

# Analyzing health infrastructure investment in Lesotho

An investigation into the benefits of a multimillion dollar investment in Lesotho's health care infrastructure estimates it will result in an extra one million life years lived in the kingdom between 2010 and 2019



Photos © Eva-Lotta Jansson/IRIN/Red Cross

reduce maternal mortality by 50 percent. Making the same assumption as above about the distribution of births and the absence of competing hazards, this would add almost another 7,000 life years.

According to the World Health Organization (WHO) Lesotho Mortality Profile, one-third of all infant deaths, and two-thirds of all non-AIDS infant deaths, are neonatal; that is, they occur in the days immediately following birth. Some 17 percent of non-AIDS infant deaths are due to birth asphyxia and 21 percent are due to neonatal infection, caused in general by unsanitary conditions. The MCC project, by eliminating these easily addressed causes

of infant death, could reduce non-AIDS infant mortality by 38 percent, amounting to 9,100 deaths averted. Under the same assumptions as above, the gain in life years lived would be about  $5 \times 9,100$  or close to 50,000 life years.

When these “bottom-up” estimates of life years saved were combined with more speculative estimates for lives saved by more effective blood screening (one of the components of the infrastructure project) and prevention efforts (VCT, treatment of sexually transmitted diseases, community outreach, etc.) that could be made possible by enhanced infrastructure, it was estimated that, overall, the project would result in an

extra one million life years being lived in Lesotho between 2010 and 2019. As we took no account of tuberculosis or health issues other than those discussed above, this should be taken as a conservative estimate.

Putting a value on human life is a problem that has vexed economists for many years, and there is no consensus on the best approach. An often-used expedient is to value one year of life at the value of GDP per capita. At current exchange rates, this means that the million life years saved between 2010 and 2019 would have a monetary value of US\$600 million—to be contrasted with total capital and recurrent costs of only US\$166 million. By any reasonable metric, the project is a sound investment.

Some may object that the valuation of each life year saved at US\$600 is wildly uncertain, or that the entire idea of attaching a price tag to life is fraught with moral pitfalls. But another approach, the cost-effectiveness approach, also strongly indicated that the project was sound. The cost per life year saved in 2010–2019 was US\$166, or US\$122 if only the MCC expenditure is included. Comparison with other health interventions in Africa shows that this is well within the range of interventions considered to be a “good buy.”

No assessment is without risks. Perhaps the most prominent of these is that the Ministry of Health may experience difficulty staffing the upgraded facilities in view of the serious brain drain of medical personnel to South Africa and the United Kingdom. However, better facilities, including living quarters, should serve as a strong inducement not to leave for jobs abroad. Also to be considered is the risk that the Ministry of Health may find itself unable to meet the recurrent expenditure needs associated with the new infrastructure. But a comparison of estimated needed recurrent expenditure shows that it is not out of line with the Medium Term Expenditure Framework in place; and donors such as the Clinton Foundation stand ready to supply AIDS drugs at moderate costs. MCC plans to complement these pre-estimates of the health benefits with an impact evaluation that measures the actual outcomes. ■

**Further information** IIASA’s Health and Global Change Project at [www.iiasa.ac.at/Research/HGC](http://www.iiasa.ac.at/Research/HGC)

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**Associate Professor William McGreevey**, a long-time collaborator of IIASA’s HGC Project, is in the Department of International Health at Georgetown University.

### Strengthening science academies to inform health policies in Africa

Successful development in Africa will depend not only on investment in scientific research, but also on the application of scientific research results to decision making. Science academies in African nations offer promise for organizing the intellectual community of a nation in an advisory capacity to government. Primarily institutions of an honorific tradition, science academies have the independence and expertise to offer authoritative advice on national policy development and implementation.

The African Science Academy Development Initiative (ASADI)—a 10-year effort launched in 2004 by the U.S. National Academies—is strengthening the capability of African science academies to inform health policymaking. Major investments in the academies of science of Uganda, South Africa, and Nigeria support the development of staff, infrastructure, and rigorous procedures for providing advice. Modest investments in the academies of Ghana, Cameroon, Senegal, Kenya, and the regional African Academy of Sciences support strategic planning efforts. Annual gatherings sponsored by the program at the regional level promote progress sharing and relationship building among program participants.

African science academies involved with ASADI have developed an array of important products to inform government policymaking—workshops, discussions forums, and in-depth studies authored by formally constituted committees. For example, a study released in 2007 by the Academy of Science of South Africa reviewed the scientific evidence relating to the influence of nutrition on HIV/AIDS and tuberculosis (TB). Challenging national policies that promote controversial nutritional remedies for HIV/AIDS treatment, the report concluded that neither food nor food supplements are alternatives to drug therapy in treating HIV/AIDS and TB. At the Nigerian Academy of Science, a standing Forum on Evidence-Based Health Policymaking has been established to bring together diverse stakeholders from government, academia, industry, nongovernmental organizations for regular discussion and information exchange about emerging health-policy topics—blood safety, child mortality, health systems, and primary health care. ■

**Further information** List of sources available online at [www.iiasa.ac.at/Options/sources](http://www.iiasa.ac.at/Options/sources)

**Clara Cohen** is a research scholar in IIASA’s Health and Global Change Project and a staff officer to the U.S. National Academies.



Manthabiseng Matthews has the difficult job of persuading her granddaughter, Limpho, to take her daily anti-retroviral treatment medicine.

CLIMATE AND DEVELOPMENT

# Making climate forecasts useful in a changing climate

Climate models have been able to predict El Niño/Southern Oscillation (ENSO)—a multiannual cycle in the tropical Pacific Ocean measured through changes in sea surface temperature and atmospheric pressure—since the early 1990s. Particular climate patterns in Africa associated with phases of the ENSO cycle have also been identified by climatologists—during an El Niño, for example, much of southern Africa often experiences low seasonal rainfall and poor crop yields. These two factors have made it possible for climatologists to forecast likely seasonal rainfall and temperature anomalies. But how could these forecasts be used to help development efforts in Africa?

In September 1997 a group of meteorologists and representatives from government ministries, nongovernmental organizations, and private businesses held the first regional Climate Outlook Forum (COF) in Kadoma, Zimbabwe. Their task: to negotiate a single consensus forecast for the entire region that would be backed by the regional Drought Monitoring Centre (DMC) in Harare and their own national meteorological and hydrological services (NMHS). COF also began consultations with potential forecast users. Such was the enthusiasm for COF that East and West Africa held their own COFs the following year. Since then, COFs have taken place regularly in three African regions, and in Latin America, the Caribbean, and Asia.

The immediate results were not encouraging. In mid-1997 El Niño conditions led to a forecast of dry conditions over most of southern Africa. In Zimbabwe banks restricted credit and farmers reduced planting. When near normal rains actually fell in much of the country, harvests suffered and people accused the COF organizers of misleading them. One problem was that people did not grasp the probabilistic nature of the forecasts; another was that, even if they did, they would not base any firm commitments on it. For example, in 1999 in Ethiopia, though a high likelihood of drought was forecast, organizations failed to mobilize resources until the actual rainfall data confirmed the crops would fail.

Since then, positive examples have emerged. In Ethiopia in 2002 a high likelihood of drought was predicted. Unlike in 1999 an emergency management team began meeting shortly after the COF to identify what actions to take, and donors began making commitments before things grew critical. In Mali a pilot project

operating since 1982 has helped farmers base their decisions on weather forecasts of up to 10 days' lead time. Seasonal forecasts became available in 1998. A 2004 survey found income gains of 10–80 percent among participating farmers compared with a control sample. A similar 2000–2005 pilot project in Zimbabwe led by this author, also showed gains from forecast use. Preseason climate workshops held each year in four villages with the participation of a random sample of subsistence farmers showed gains in yields averaging 9 percent among farmers who based decisions on the forecast.

A series of studies starting in the 1990s, the Southern African Malaria Outlook Forum (MALOF), launched by the World Health Organization and partners in 2004, established clear relationships between malaria transmission rates and location-specific climatic conditions. The MALOF studies appear to have led to marked reductions in mortality and morbidity the following year.

So what preconditions are needed for forecasts to be useful? First, forecasts must provide information that is specific to users' needs, going beyond what climatologists and the COFs now provide. To predict crop yields, for example, the forecast must be combined with indicators such as soil moisture. Currently, the climate information available is not catchment-specific.

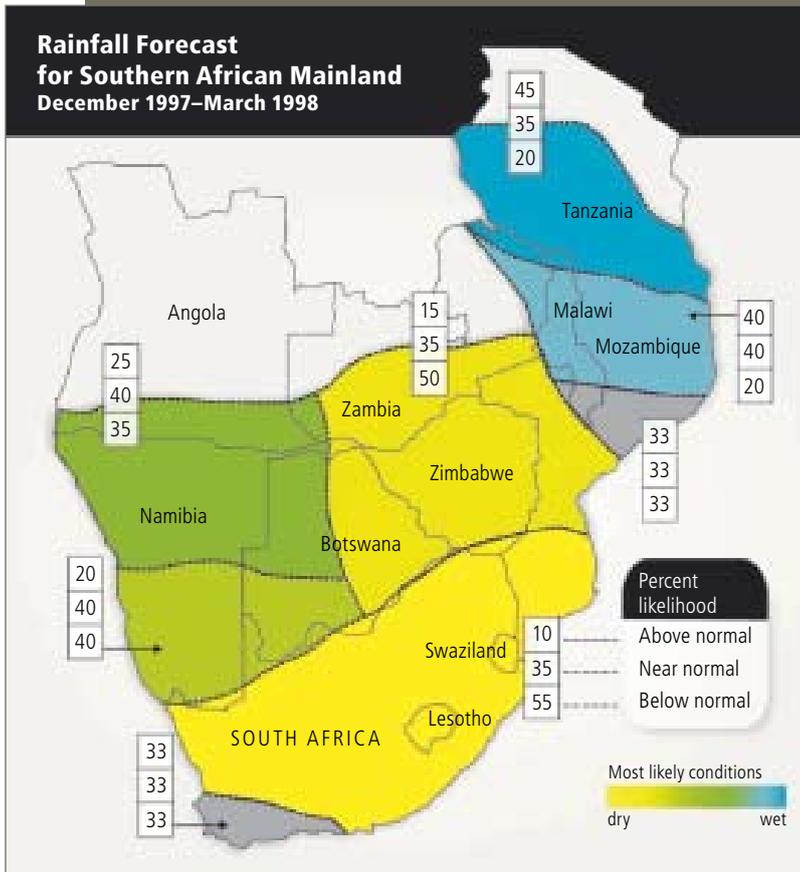
Second, forecasters need to work in partnership with potential users to develop and interpret forecasts, as happens with MALOF. One result of this collaboration has been greater attention to historical climate and real-time weather data, which are often more relevant for malaria control efforts than the preseason forecast. Agricultural experts have repeatedly identified a similar need for sector-specific information, but have participated little in planning the agendas and forecasting activities for subsequent COFs. Thus attention has remained focused on predicting seasonal rainfall totals, which are less useful.

Third, as probabilistic forecasts of climatic anomalies are hard to understand, communication efforts and decision-support tools need to involve, rather than address, potential users. The Zimbabwe study cited above found that farmers who had participated in preseason forecast workshops were five times more likely to be influenced by the forecasts than those who had heard them via the media.

Improving the capacity for forecast use may be an effective way for Africa to prepare for climate change, but it is important to recognize what forecasts can and cannot accomplish. The types of decisions that people make because of access to forecasts are not necessarily the same as they will make because of climate change. For example, in the Zimbabwe study, people benefited from forecast use because they planted higher-yielding, water-intensive crop varieties in the years when good rains seemed likely. But Zimbabwe is likely to experience these good years less often in the future because of climate change. The benefit, rather, is in the partnerships for climate information processing and delivery that forecast application demands. Trying to use forecasts now is the best way to build and test these partnerships, and these will play an integral role in climate adaptation in the future. ■

**Further information** Patt AG, Ogallo L, & Hellmuth M (2007). Learning from 10 years of climate outlook forums in Africa. *Science*, 318(5847):49–50.

**Dr. Anthony Patt** is a research scholar in IIASA's Risk and Vulnerability Program.



Seasonal forecast issued at the Kadoma COF, September 1997. Climatologists classify historically observed seasonal rainfall into the terciles: below normal, near normal, and above normal. Each tercile corresponds to a specific range, measured in millimeters of rain within a defined period of time, such as December–March, observed at each weather station in one-third of the years of the historical record. The forecast suggests how the probabilities of rain falling within each range will differ from one-third during the coming season. The forecast divides the region into distinct zones, within each of which the response to external forcing such as ENSO will likely be similar. In some zones, such as the gray zone falling over the southern tip of the continent, external forcing is shown to have no effect. In other zones, such as the yellow zone falling over most of South Africa, the external forcing has a strong influence. [From Patt AG, Ogallo L, & Hellmuth M (2007). Learning from 10 years of climate outlook forums in Africa. *Science*, 318(5847):49–50. Reprinted with permission from AAAS.]

# Globalization

According to the Global Forest Resource Assessment for 2005 of the Food and Agriculture Organization (FAO), Africa has 635 million hectares (ha) of what is classified as forests, corresponding to about 21 percent of its land area. Africa's forest accounts for 15 percent of the world's forest areas, and the growing stock (volume) of the African forests is 65 billion m<sup>3</sup> or about 15 percent of the world's growing stock. That is the good news.

The bad news is that, in many states of Africa, forests are under pressure. Overharvesting and other disturbances have taken their toll, resulting in declining forest area, growing stock, and biomass, as well as a degradation of the forests generally.

**EXPONENTIAL GROWTH RATE** During the past 10–15 years, the globalization rate has increased rapidly, driven by emerging economies like China, India, and Brazil: policy changes, liberalization of legislation, and implementation of new technologies like Information and Communication Technology (ICT) are among globalization's main forces. Indeed, globalization is often seen as "the bad guy," as an unfortunate effect of so-called progress.

Globalization, however, is far from being a contemporary phenomenon. In his 2007 book, *Bound Together: How Traders, Preachers, Adventurers and Warriors Shaped Globalization*, Nayan Chanda of the Yale Center for the Study of Globalization writes of globalization: "It has worked silently for millennia without being given a name and is probably as old as humanity itself, and as complex and unpredictable. It moves through a multitude of threads connecting us to far away places from an ancient time." In the 21st century, globalization represents the economic aspirations and desires of hundreds of millions of people around the globe and, of course, its effect is exponential. The more people that become involved, the faster globalization goes.

There are many definitions and meanings of globalization around. However, in this article we will deal with *economic globalization*, which we define as *integration of economic activities via markets*. Economic globalization, which can in turn drive social, cultural, and political globalization, affects most of the existing economic sectors of the world, including the forest sector.

So what will the increased globalization mean for Africa's forest resources? The global analysis carried out by IIASA's Forestry (FOR) Program with respect to production/utilization of forest industrial raw material in 2030 is illustrated for pulp logs and saw logs in the two charts (*right*).

**AFRICA: FUTURE GLOBAL SUPPLIER** As can be seen in the charts, FOR assesses that pulp log production in Africa will increase from the current 20 million m<sup>3</sup>/year to 75–90 million m<sup>3</sup>/year and saw logs from the current 35 million m<sup>3</sup>/year to 100–150 million m<sup>3</sup>/year. This strong increase in the industrial utilization of the forest resources is a result of the tight supply/demand situation at the global level. Africa will in the future take a larger part of the global supply—and this trend has already started. The more difficulties that countries such as China and India face in terms of wood supply from domestic sources and from traditional suppliers in Asia, the more they are turning to new suppliers in Africa and Latin America.

**CHINA: IMPORTING MORE LOGS** China, in particular, is carrying out substantial general investment programs in the countries in these two regions to get access to increased volumes, not just of forest resources but of other natural raw materials. It is currently importing

The increased utilization of Africa's forest resources, due to globalization, will substantially increase the pressure on them. Thus, measures need to be taken now to secure a sustainable utilization of industrial wood in Africa. Moreover, if the income from the increased export of forest products is wisely used and distributed, globalization can, in fact, contribute to Africa's development.

## WHAT AFRICA AND EUROPE HAVE IN COMMON

Many globalization effects will have a similar impact on the future of European and African forest resources. The European Commission asked IIASA's Forestry Program to analyze the effects of globalization on the economic viability of Europe's forest sector. Findings include:

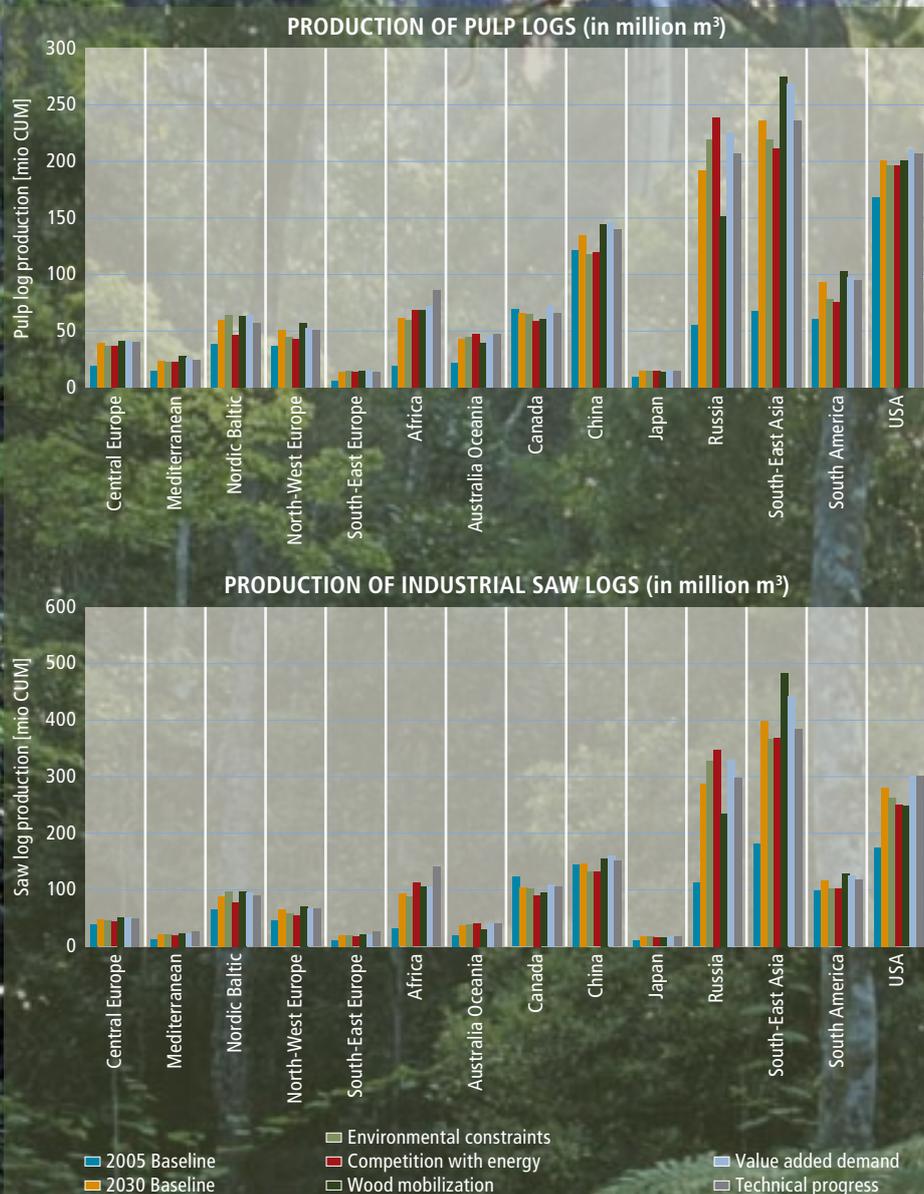
- The global footprint of growth (declining growth in the North and rapid growth in the South of consumption of forest products)
- Globalization of fiber markets (the supply of wood is becoming tight and triggers more trade and structural changes)
- Globalization of product markets (trade in forest products growing rapidly—faster than growth in production and consumption)
- Globalization of energy markets (energy demand driven by emerging economies causing a rapidly growing interest in bioenergy which, in turn, causes increased competition over wood raw material)
- Climate change (affecting future forest production, but also driving the demand for bioenergy in order to reduce emissions of greenhouse gases)

2.5 million m<sup>3</sup> of roundwood equivalents of forest products from Africa per year, some 90 percent of which is in the form of logs. The major suppliers are Cameroon, Equatorial Guinea, Gabon, Mozambique, Republic of Congo, and Swaziland. This situation is mirrored in the European Union, India, and other countries and regions.

**SUSTAINABILITY NEEDED** The FOR analysis, represented in the charts above, shows this development growing rapidly, as globalization grows. The increased utilization of Africa's forest resources will substantially increase the pressure on them. That is why measures need to be taken now to secure a sustainable utilization of industrial wood in Africa. On the other hand, if the

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# and Africa's forests



income from the increased export of forest products is wisely used and distributed, globalization can contribute to the development of the societies in the region, and Africa can gain from it.

**FORESTS FOR ENERGY** But it is not only the globalization of industrial wood products that will affect the utilization of the African forest resources. In parallel, the globalization of the energy markets is triggering increased use of wood and forest biomass for energy production. In its latest 2003 African Outlook Study, FAO finds that total roundwood production in Africa in 2030 will include production of wood for fuelwood and charcoal that is four times higher than the production of industrial wood. Industrial wood production will

be some 200 million m<sup>3</sup> in 2030 according to IIASA's FOR study (see charts). This means that there will also be a tremendous demand for wood for fuelwood and charcoal consumption in Africa. The total utilization will be of the magnitude of 1 billion m<sup>3</sup>/year in 2030 compared to the current 650 million m<sup>3</sup>. ■

**Further information** Rametsteiner E, Nilsson S, Böttcher H, Havlik P, Kraxner F, Leduc S, Obersteiner M, Rydzak F, Schneider U, Schwab D & Willmore L (2007). *Study of the Effects of Globalization on the Economic Viability of EU Forestry*. Available at [http://ec.europa.eu/agriculture/analysis/external/viability\\_forestry/index\\_en.htm](http://ec.europa.eu/agriculture/analysis/external/viability_forestry/index_en.htm).

**Professor Sten Nilsson** is Acting Director of IIASA and leader of IIASA's Forestry Program.

SCIENCE ADVISORY COMMITTEE

## Death of Bert Bolin



IIASA lost a good friend on 30 December 2007 when Bert Bolin passed away after a period of illness at the age of 82. Until summer 2007 he chaired IIASA's Science Advisory Committee (SAC), an international advisory group of senior researchers, and it was in this capacity that he

helped to originate the Institute's Global Energy Assessment and to solidify its vision.

Perhaps the crowning achievement of his life and work was the success of the United Nations Intergovernmental Panel on Climate Change, of which he was co-founder and first chairman and which he steered through the first two of its influential climatological assessment reports. In his tribute, United Nations Secretary-General Ban Ki-moon spoke of Bert Bolin's "immeasurable contribution, not only in being one of the first to recognize the consequences of increasing emissions of greenhouse gases decades ago, but also in alerting the world to what was required by Governments to protect our planet from the impact."

Indeed, the concerns expressed in the first report led to the drafting of the United Nations Framework Convention on Climate Change in August 1990, the first international document bringing nations together to deal with the issue. The second assessment in 1995 led to the Kyoto Protocol, which called on industrialized countries to collectively limit or reduce greenhouse gas emissions by about 5 percent below 1990 levels by 2012.

The present Chairman of the IPCC, R.K. Pachauri, had requested Bert Bolin to travel to Oslo to accept the Nobel Prize on behalf of the IPCC (see "2007 Nobel Peace Prize," page 29), but he was too ill to travel. However, he was said to be "thrilled" as first IPCC Chairman that the Nobel Committee had recognized the IPCC's work in this way. ■

FORESTRY

## IIASA forester influences international policy

Ewald Rametsteiner, a research scholar with the IIASA Forestry (FOR) Program, has been working in the past year with a number of international bodies to help develop forestry policy: work that has resulted in major publications.

At the New York headquarters of the United Nations Forest Forum (UNFF)—the highest global forestry body and platform—he worked on outlining a strategic direction for better linking of global policymaking and local/regional sustainable development needs. In this connection, he was in charge of scientific editing of the UNFF publication, "Enabling Sustainable Forest Management: A Discussion on Strategies for Equitable Development, for Forests, for People," to be published next month.

Dr. Rametsteiner also worked with the Ministerial Conference on the Protection of Forests in Europe (MCPFE) and the United Nations Economic Commission for Europe (UNECE) and Food and Agriculture Organization (FAO) to co-edit the authoritative scientific report "State of Europe's Forests 2007" which, when presented at the 5th Ministerial Conference of the MCPFE in Warsaw, Poland,



in November 2007, was hailed as "the most comprehensive and balanced report ever produced on sustainable forest management in Europe."

Dr. Rametsteiner was also invited to act as an expert for a number of other bodies, including the FAO/UNECE/MCPFE inter-secretariat working group on policies, legal, and institutional frameworks, designing a questionnaire aimed at substantially improving the data availability and accuracy of global data related to forest policy and institutions, and recently published "Europeans and their Forests—What do Europeans think about wood and its uses? A Review of Consumer and Business Surveys in Europe," also co-produced with the FAO/UNECE/MCPFE. ■

[www.un.org/esa/forests](http://www.un.org/esa/forests)  
[www.mcpfe.org/files/u1/publications/pdf/FE\\_EN.pdf](http://www.mcpfe.org/files/u1/publications/pdf/FE_EN.pdf)

ENERGY

## IIASA scientists right on message

IIASA's Energy (ENE) Program's MESSAGE Model (Model for Energy Supply Strategy Alternatives and their General Environmental Impact) plays a central role in a wider climate change community effort. It is geared toward providing input to a potential Fifth Assessment Report (AR5) of the United Nations Intergovernmental Panel on Climate Change (IPCC).

The IPCC decided in 2006 that the research community itself should undertake scenario development for a possible AR5 and that the IPCC's role would be limited to catalyzing and assessing such work. At an IPCC Expert Meeting on New Emissions Scenarios in Noordwijkerhout, Netherlands, in 2007, it was decided that MESSAGE will provide one of the four Representative Concentration Pathways (RCPs) to serve throughout future research phases as an

analytical thread between the integrated assessment, impacts, adaptation, and Earth system modeling communities involved in scenario development for the AR5. MESSAGE scenarios are complemented by central information from other IIASA Programs including World Population, Land Use Change and Agriculture, Forestry, and Air Pollution and Economic Development. These RCPs will be used by all major climate models to develop an ensemble of climate projections for both the near term (next few decades) and long term (next few centuries).

The summary report of the Noordwijkerhout meeting is under preparation, with two ENE scientists as Lead Authors and one ENE scientist as a Steering Committee member of the responsible IPCC Task Group. ■  
[www.iiasa.ac.at/Research/ENE/model/message.html](http://www.iiasa.ac.at/Research/ENE/model/message.html)

## 2007 NOBEL PEACE PRIZE

**IIASA scientists among winners**

Seventeen IIASA scientists who co-authored the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) were among the recipients of the 2007 Nobel Peace Prize, which was bestowed jointly on the IPCC and former U.S. Vice President Al Gore "for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change."

The collective IIASA achievement was announced on 14 November 2007 by Director Leen Hordijk at the opening of the IIASA Conference '07. The Director spoke of his pride in the IIASA scientists who participated in the research for the Fourth Assessment Report. "That number [17] is huge when you look at it from a global perspective," he commented, "because it's much more than prestigious American universities like Yale and Princeton, and it's almost equal to the combined number of Harvard and MIT."

The Nobel Peace Prize was presented in Oslo, Norway, on 10 December 2007. R.K. Pachauri, Chairman of the IPCC, accepted the prize on behalf of the organization. In his acceptance speech he spoke, among other things, of "the power and promise of collective scientific endeavour, which, as demonstrated by the IPCC, can reach across national boundaries and political differences" as well as "the importance of knowledge in shaping public policy and guiding global affairs." ■

[www.nobelprize.org](http://www.nobelprize.org)

## YSSP SCHOLARSHIPS

**2007 awards announced**

The Peccei and Mikhalevich Scholarships, awarded each year to outstanding participants in IIASA's Young Scientists Summer Program (YSSP), have been conferred for 2007 on Marta Vicarelli of Italy and Andries Richter of the Netherlands, respectively.

Marta Vicarelli is a Ph.D. candidate in sustainable development and research assistant at the Center for Climate Systems Research of Columbia University, New York and, since 2004, a research fellow at the NASA Goddard Institute for Space Studies. During her three-month stay in the Risk and Vulnerability Program, she completed a study entitled "Integrating Inter-annual Climate Variability Forecasts into Weather-indexed Crop Insurance," which analyzed rainfall-indexed insurance contracts designed for Malawi, Kenya, and Tanzania. Her study was rated by reviewers as "substantially contributing to the development of methodologies for both analysis and implementation of innovative insurance schemes... a complex issue that requires a combination of climatic, agronomic, economic and financial expertise."

The research project and paper of first year Ph.D. student Andries Richter from Wageningen University, the Netherlands, seconded to the Evolution and Ecology Program was "The Evolution of Social Norms for Renewable Resource Exploitation." ■

Andries Richter  
(Netherlands)  
Wageningen University



Marta Vicarelli (Italy)  
Columbia University



Aron Larsson (Sweden)  
Mid-Sweden University



His report was praised for "addressing a real social issue by gathering information on ethical attitudes and reputation effects... not hitherto gathered." Another reviewer said Andries' paper should be read by "all students of ecology and public administration who are going into government service."

Aron Larsson of the Mid-Sweden University was honorably mentioned for his research work in the Integrated Modeling Environment Project. ■

[www.iiasa.ac.at/YSSP](http://www.iiasa.ac.at/YSSP)

## NATIONAL MEMBER ORGANIZATIONS

**Republic of Korea joins IIASA**

The Korea Science and Engineering Foundation (KOSEF), based in Daejeon, South Korea, became the latest IIASA National Member Organization, effective



from 1 January 2008. Joining IIASA is seen by the Government of Korea as part of its efforts to further cultivate a science and technology-based society. ■

[www.kosef.re.kr/english\\_new](http://www.kosef.re.kr/english_new)

## CARBON OFFSET

**Reducing IIASA's carbon footprint**

IIASA wants to minimize its impact on the Earth's climate and has invested over €8000 in projects that help offset carbon generated by its flights in 2007. The nature of IIASA's work results in a lot of air travel. The Institute brings together scientists from around the world to research at its offices, a former Habsburg imperial palace in Austria. Its scientists also visit hundreds of locations around the world to disseminate its research. As an alternative to flying, IIASA has also recently installed a video conference system. ■



W. Brian Arthur



Paul J. Crutzen



Serguei Glaziev



Martin Parry



David G. Victor

## Where are they now?

Working at IIASA can have a profound impact on a person's career, opening doors to positions in academia, government, industry, and business, as these brief notes on five of our alumni show only too well.

Keep in touch with fellow IIASA alumni/ae by joining the IIASA Society.

[www.iiasa.ac.at/IIASA\\_Society](http://www.iiasa.ac.at/IIASA_Society)

**W. BRIAN ARTHUR** is widely known for developing a theoretical framework for economic allocation under increasing returns. His research shows how powerful firms can exploit the peculiar nature of high-tech markets to the disadvantage of opponents who offer better products. The work provided the intellectual underpinnings for the U.S. Department of Justice's antitrust case against Microsoft.

The Irish economist developed much of his analysis on increasing returns while working at IIASA from 1977 to 1982 and again in the summer of 1983. IIASA's unique environment, bringing leading scientists from different disciplines and countries together in interdisciplinary work, was crucial. "It was an extremely productive time," he says of IIASA.

Brian Arthur is currently External Professor at the Santa Fe Institute and Visiting Researcher at the Intelligent Systems Lab, PARC. In 1990 he won the prestigious Schumpeter Prize in Economics for his work on increasing returns.

**PAUL J. CRUTZEN** won the Nobel Prize in Chemistry in 1995 for his work in atmospheric chemistry, particularly concerning the

formation and decomposition of ozone. Born in Amsterdam, Paul Crutzen trained as a civil engineer. He is currently Emeritus Director of the Atmospheric Chemistry Division of the Max Planck Institute for Chemistry, Mainz, and Professor at the Scripps Institution of Oceanography of the University of California at San Diego.

Paul Crutzen has had a long-standing affiliation with IIASA, starting in the 1980s when he collaborated with IIASA's Sustainable Development of the Biosphere Project. Since 2004, he has also been an IIASA Institute Scholar researching, among others, the nitrous oxide emissions from biofuel production. Of IIASA, he says: "Only an international, interdisciplinary research institute like IIASA can bring together experts from numerous disciplines and countries to effectively examine the global challenges facing our world. I only regret not having more time to spend at IIASA."

**SERGUEI GLAZIEV** is a Russian politician and former Presidential candidate for Russia in 2004. He studied economics at Moscow State University and researched at IIASA in 1988 as a young scientist in the Technological and Economic Dynamics Project.

He served as Russia's minister for foreign economic relations from 1992 to 1993. He has also been elected member of the State Duma for various periods since 1994.

Commenting on IIASA's Young Scientists Summer Program, Serguei Glaziev says: "The YSSP experience helped me to understand more about the world and life in general. I have also benefited from the new information and research opportunities that the IIASA network provides." ■

**MARTIN PARRY** led IIASA's Climate Impacts Project from 1983 to 1987. Long before climate change was widely recognized as a major problem, Parry's team analyzed how climate changes will impact on crop productivity. The project researched how these impacts will affect economies, societies, and the environment, and the practical policies to respond to such changes.

More than 20 years later, the British geographer continues to lead international teams of researchers in this field. He is currently the co-chair of the Intergovernmental Panel on Climate Change's (IPCC) Working Group II, and so shared the 2007 Nobel Peace Prize with all IPCC scientists.

**DAVID G. VICTOR** is Professor of Law at Stanford Law School and Director of the Program on Energy and Sustainable Development at Stanford University's Freeman Spogli Institute for International Studies. His research interests range from energy policy to climate change policy.

He developed much of his interest in these areas while working at IIASA in the 1990s when he co-led the project on "Implementation and Effectiveness of International Environmental Commitments." The project conducted 14 historical case studies on topics ranging from the regulation of acid rain in Europe to the limitation of trade in hazardous chemicals and pesticides.

Of IIASA, he says: "The Institute changed how I think about the world... Ever since 1989 when I came to IIASA as a young scientist, I have worked on technological change with the energy group. Over the long term, technological change is the dominant force in energy and environmental problems." ■

# day in the life

## Food for thought

When IIASA's busy postdoctoral researchers spend an evening together, food choices can be wide-ranging: from curry to sushi and from fish and chips to feijões



If the Institute consciously tried to select its four current postdocs based on different cultures and lifestyles, then it truly surpassed itself. Over a typically Austrian lunch at IIASA's Schloss Restaurant, the postdocs from Brazil, India, Japan, and the UK discuss IIASA and the pros and cons of the program here.

**Tapas Mishra** is a macroeconomist and econometrician who has deftly combined the theoretical architecture in these disciplines to explain stochastic demographic systems. His current research with IIASA's World Population Program concentrates on the distributional effects of human capital on democratic governance, social cohesion, and uncertain economic growth—quite a mouthful, he admits. Tapas believes that the challenges facing society today cannot be solved through the perspective of a single discipline. "Universities are lagging behind," he says. "Being able to consult with scientists engaged in other disciplines at IIASA definitely provides insights for my own research."

**Katsumasa Tanaka** agrees wholeheartedly. A natural Earth system modeler in IIASA's Population and Climate Change Program and Greenhouse Gas Initiative, the former 2005 YSSPer is spending two years at IIASA tackling various questions related to uncertainty in the Earth system (such as climate sensitivity). While the self-confessed sushi lover has had some difficulty adapting to Austrian cuisine, his former interdisciplinary/international experience has helped him settle in quickly to IIASA's working style. "The interdisciplinary perspective helps give me a fresh look at problems—in my case, uncertainty," he comments, "and there is an increasing demand for an interdisciplinary approach within the job market."

In career terms, IIASA is ideal for **Christopher Doll** from the UK because of the thematic organization of its research programs and emphasis on policy relevance. Working at IIASA's Greenhouse Gas Initiative (GGI) and Transitions to New Technologies Program, he is analyzing the GGI's spatially modeled datasets to consider the implications for global development to 2100. Previously at The Earth Institute at Columbia University in New York, where the focus was on immediate intervention strategies, he finds IIASA's emphasis on "where does this lead in the future?" a neat complement. "Systems analysis is fundamental to interdisciplinary research," Christopher says, "to refine our understanding of human–environment interactions."

**Edmar Teixeira**, working on enhancement of the FAO/IIASA Agro-ecological Zones (AEZ) methodology in IIASA's Land Use Change and Agriculture Program, not only eats feijões, but knows how to grow them. After gaining an M.Sc. in agronomy at the University of São Paulo, he worked for six years as a technical advisor to central Brazil's food industry. His Ph.D. is from Lincoln University, New Zealand, whereafter he conducted research at the Plant Production Systems Group at Wageningen University in the Netherlands. With so much practical work experience behind him, Edmar feels you should aim for a postdoctoral position at IIASA if you want to make a difference in the real world. Indeed, he says, an IIASA "outlook" is a career plus if a candidate has a strong desire to influence policymaking using science-based information.

Postdoctoral research is definitely an "hors d'oeuvre" to the "main course." Indeed, the "career" is always at the back of a postdoc's mind. All our postdocs feel that career paths in interdisciplinary research are not "obvious" and that knowing about the career paths of other scientists who have passed through IIASA could help them.

Such information would, one might say, help future postdocs better digest the possibilities on the table at IIASA and win their just "desserts." ■



Christopher Doll



Katsumasa Tanaka



Edmar Teixeira



Tapas Mishra

### Typical Postdoc's Day

- 7.30 Breakfast
- 8.30 Arrive at IIASA
- 8.30–12.30 Modeling work, consultations with colleagues
- 12.30–13.30 Lunch together at IIASA's Schloss Restaurant
- 13.30–17.30 Check out new data sources, meet with scientists from other programs, write up work
- 18.00 Leave IIASA
- 19.30 Fish and chips, feijão, curry, or sushi time

# IIASA



Bringing together scientists from different countries and disciplines to research global change, IIASA is funded by the following scientific organizations:

- ▶ The Academy of Scientific Research and Technology, Egypt
- ▶ The Association for the Advancement of IIASA, Germany
- ▶ The Austrian Academy of Sciences
- ▶ The Estonian Association for Systems Analysis
- ▶ The Finnish Committee for IIASA
- ▶ The Japan Committee for IIASA
- ▶ The Korea Science and Engineering Foundation
- ▶ The National Academy of Sciences, United States
- ▶ The National Natural Science Foundation of China
- ▶ The National Research Foundation, South Africa
- ▶ The Netherlands Organization for Scientific Research
- ▶ The Pakistan Academy of Sciences
- ▶ The Polish Academy of Sciences
- ▶ The Research Council of Norway
- ▶ The Russian Academy of Sciences
- ▶ The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning
- ▶ The Technology Information, Forecasting and Assessment Council, India
- ▶ The Ukrainian Academy of Sciences



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