



Activities with Member Countries

India

iiasa info sheet

Research collaborations between IIASA and India stretch back to the 1970s, but the relationship has recently become far more productive after India became a national member of IIASA in 2007 through the Technology Information, Forecasting and Assessment Council (TIFAC). Multiple research collaborations with partners in India as diverse as the National Institute of Hydrology (NIH) and The Energy and Resources Institute (TERI) have brought new insights to the challenges that India faces. In particular, IIASA's applied systems analysis has brought a global perspective, interdisciplinary research expertise, and policy relevance to issues ranging from the future of India's energy system to increasing the country's food production. Greater collaboration with IIASA has also brought Indian researchers into contact with the Institute's global network of around 2,500 active researchers and 300 research partners. These often informal connections, along with the official projects of the India-IIASA programme have resulted in over 160 joint publications since 2008. IIASA's academic training programs have also been successfully building the next generation of systems analysts in India. This IIASA Info Sheet provides a summary of this growing and mutually beneficial relationship since 2007.

Highlights of Interactions Between IIASA and India	
IIASA National Member Organization (NMO)	Technology Information, Forecasting and Assessment Council (TIFAC)
Membership start date	January 2007
Key research partners	45 organizations from India collaborate with IIASA including: <ul style="list-style-type: none"> ■ Centre for Water Resources Development and Management (CWRDM) ■ Indian Institute of Forest Management (IIFM) ■ Indian Institute of Management (IIM), Ahmedabad ■ Institute of Rural Management Anand (IRMA) ■ Institute for Social and Economic Change (ISEC) ■ Integrated Research and Action for Development (IRADe) ■ International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) ■ National Environmental Engineering Research Institute (NEERI) ■ National Institute of Hydrology (NIH) ■ The Energy and Resources Institute (TERI)
Areas of research collaboration	<ul style="list-style-type: none"> ■ Improving land, soil, and water management in India ■ India's energy future ■ Smart ways to clean up India's air ■ Energy and climate change modeling ■ Increasing India's resilience to natural disasters ■ Projecting India's future population ■ Managing India's forests for the future
Capacity building (since 2007)	<ul style="list-style-type: none"> ■ 22 young scientists from India have participated in IIASA's Young Scientists Summer Program ■ 3 in IIASA's Postdoctoral Fellowship Program ■ 6 in the Southern African Young Scientists Summer Program ■ 17 training workshops for researchers and policymakers in India
Publication output	168 publications have resulted from collaborations between IIASA and Indian nationals since 2008
Other interactions	<ul style="list-style-type: none"> ■ Nearly 150 Indian nationals have participated in IIASA events since 2008 ■ On average 9 Indian nationals have been employed by IIASA every year since 2008

Activities with Member Countries: India

IIASA Info Sheet 15/02
January 2015

The electronic version of this document is available at
www.iiasa.ac.at/india

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ZVR 524808900

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IIASA Info Sheets provide succinct summaries of IIASA activities.
They do not necessarily reflect the views of IIASA staff, visitors,
or National Member Organizations.

This Info Sheet summarizes IIASA's recent interactions with India.
It includes highlights, with links to further information, and is
not meant to be a comprehensive report on all interactions.

Feedback and updates are encouraged and should be sent to Iain Stewart.

IIASA's National Member Organization in India

In January 2007 India, through the Department of Science and Technology's Technology Information, Forecasting and Assessment Council (TIFAC) formally joined IIASA as a National Member Organization (NMO) and established the India–IIASA Programme to oversee research collaborations and capacity-building activities between the Indian research community and IIASA.

Professor Prabhat Ranjan, Executive Director of TIFAC, is the IIASA Council Member for India and along with the representative of each of IIASA's member countries governs the Institute. Professor Ranjan is also the Vice Chair of the Program Committee of the IIASA Council which advises IIASA on the development of its research programs.

TIFAC has established a national committee for the India–IIASA Programme which comprises the following members:

- Dr. Kirit Parikh (Chairman)** Former Member, Planning Commission; Chairman, Integrated Research and Action for Development (IRADe), New Delhi
- Professor A.K. Gosain** Department of Civil Engineering, Indian Institute of Technology (IIT), Delhi
- Dr. Devendra Pandey** Former Director General, Forest Survey of India (FSI), Delhi
- Professor Joyashree Roy** Department of Economics, Jadavpur University, Kolkata
- Dr. S.C. Sharma** OSD-Energy Division, Planning Commission, New Delhi
- Professor Leela Visaria** Gujarat Institute of Development Research, Ahmedabad
- Dr. Pramod K. Aggarwal** Regional Facilitator, Challenge Program on Climate Change, Agriculture, and Food Security, International Water Management Institute, New Delhi
- Professor B.K. Pattnaik** Director, Institute for Social and Economic Change, Bangalore
- Professor R. Sukumar** Centre for Ecological Sciences, Indian Institute of Science, Bangalore
- Dean, Faculty of Planning & Public Policy** CEPT University, Ahmedabad
- Mr. Soumitra Biswas** Adviser & Head, India–IIASA Programme, TIFAC, New Delhi
- Ms. Sangeeta Baksi** Director, India–IIASA Programme, TIFAC; NMO Secretary for India

TIFAC's membership of IIASA builds on collaborations between IIASA and India that started in the mid-1970s on food and energy research, including the development of a framework for agricultural policy and providing assessments of energy demand in India. Today, research collaborations focus on land, soil, and water management; pathways to sustainable energy systems; tackling air pollution; and disaster risk management, among others. In addition, its work with IIASA to build research capacity among Indian scientists has been highly productive.

India's Technology Information, Forecasting and Assessment Council (TIFAC) represents India and its scholarly community on IIASA's governing Council



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Professor Kanchan Chopra, former Director of the Institute of Economic Growth in Gurgaon, was a member of IIASA's Science Advisory Committee from 2007 until 2013.

Professor Joyeeta Gupta, of the Institute for Environmental Studies at the Free University Amsterdam, was a member of IIASA's Science Advisory Committee from 2004 until 2010.

Dr. Sunita Narain, Director-General of the Center for Science and Environment in New Delhi, worked with IIASA on the Gulbenkian Think Tank on Water and the Future of Humanity.

Dr. Rajendra Pachauri, Chairperson of the Intergovernmental Panel on Climate Change and Director-General of The Energy and Resources Institute, has collaborated with IIASA's researchers in the areas of energy and climate change for over 20 years.

Dr. Jyoti Parikh, Executive Director of Integrated Research and Action for Development (IRADe), has collaborated with IIASA in the areas of energy and development since she was an IIASA research scholar in the 1970s.

Dr. Kirit Parikh, Chairman of IRADe, built and led IIASA's research programs in land use and agriculture from 1976 through 1986. He was IIASA Council Member for India from 2007 until 2013 and is now Chairman of the national committee for the India–IIASA Programme.

Dr. Leena Srivastava, Vice-Chancellor of TERI (The Energy and Resources Institute) University, was the Chair of IIASA's Evaluation Committee on Energy and Technology in 2009.

Indian nationals with senior scientific roles at IIASA and other selected collaborators

Research Partners in India

IIASA has built links with India through recently working with 45 organizations in India via formal and informal connections

IIASA works with research funders, academic institutions, policymakers, and individual researchers in India. The following list includes the names of the organizations or the individual's affiliated institutions that have all recently collaborated with IIASA.

- Acharya N.G. Ranga Agricultural University
- All India Disaster Mitigation Institute (AIDMI)
- Centre for Policy Research (CPR)
- Center for Study of Science, Technology and Policy (CSTEP)
- Centre for Water Resources Development and Management (CWRDM), Kozhikode
- Council of Scientific and Industrial Research (CSIR)
- Council on Energy, Environment and Water (CEEW)
- Earthsafe Products and Services PVT. Ltd.
- Gorakhpur Environmental Action Group (GEAG)
- Gujarat Institute of Development Research (GIDR)
- Guru Arjan Dev (GAD) Institute of Development Studies, Amritsar
- Indian Agricultural Research Institute (IARI)
- Indian Institute of Forest Management (IIFM), Bhopal
- Indian Institute of Management (IIM), Ahmedabad
- Indian Institute of Science (IISc), Bangalore
- Indian Institute of Technology Bombay (IIT Bombay)
- Indian Institute of Technology Delhi (IIT Delhi)
- Indian Institute of Technology Kanpur (IIT Kanpur)
- Indian Institute of Technology Kharagpur (IIT Kharagpur)
- Indian Institute of Tropical Meteorology (IITM)
- InsPIRE Network for Environment
- Institute of Chemical Technology (ICT), Mumbai
- Institute of Rural Management Anand (IRMA)
- Institute for Social and Economic Change (ISEC)
- Integrated Research and Action for Development (IRADe)
- International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
- International Institute for Population Sciences (IIPS)
- Jadavpur University
- Madras School of Economics (MSE)
- Ministry of Environment, Forest and Climate Change, Government of India
- Ministry of New and Renewable Energy, Government of India
- National Environmental Engineering Research Institute (NEERI)
- National Institute of Advanced Studies (NIAS)
- National Institute of Disaster Management (NIDM), Ministry of Home Affairs, Government of India
- National Institute of Hydrology (NIH), Roorkee
- National Institute of Industrial Engineering (NITIE)
- National Institute of Public Finance and Policy (NIPFP)
- National Institute of Science, Technology and Development Studies (NISTADS), Government of India
- National Thermal Power Corporation (NTPC)
- Reliance Industries Limited
- Sardar Patel Institute of Economic and Social Research (SPIESR)
- The Energy and Resources Institute (TERI)
- TERI University
- Technology Information, Forecasting and Assessment Council (TIFAC)

Recent Research Collaborations

Improving land, soil, and water management in India

South Asia—comprising Afghanistan, Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan, and Sri Lanka—has shown tremendous progress in the last four decades in food production and availability, yet a quarter of the world's hungry and 40% of the world's malnourished children and women live there. Further improving agricultural productivity is thus imperative, and a recent collaboration between IIASA and the International Crops Research Institute for the Semi-Arid Tropics in Hyderabad identified options for improving crop yields in the rain-fed systems of the semi-arid tropics.

Competition for land is also increasing. IIASA's GLOBIOM model is helping CGIAR's Climate Change, Agriculture and Food Security (CCAFS) program to quantify competition for land between agriculture, bioenergy, and forestry in South Asia. CGIAR uses the resulting plausible and quantitative future scenarios to develop viable policies with decision makers in the region. A further study determined the trade-offs and synergies between ecosystem services and livestock grazing intensity on rangelands in West India. And a new study was launched in partnership with the Institute for Social and Economic Change (ISEC) on the "Conservation of Agro-Biodiversity and Ecosystem Management: A Study in Indian Agroclimatic Sub-Zones."

Additional stresses come from climate change; and quantitative analysis by IIASA's risk team of farmer households in India revealed that access to crop insurance is crucial to increasing crop yields while adapting to climate change.

Declining soil fertility and deteriorating water quality and quantity also affect rural livelihoods. And improving land, soil, and water management are key to sustaining and improving rural livelihoods. Against this background, as part of the India–IIASA Programme, TIFAC and IIASA are conducting the following collaborative cluster of projects to build an integrated decision support system that enables concurrent analyses of these multiple issues:

- "Climate Change Adaptive Behavior for Sustainable Livelihoods" in collaboration with the Institute of Rural Management Anand (IRMA). Researchers from IRMA visited IIASA in 2014 to develop the regional version of IIASA's global agricultural model and the accompanying scenarios.
- "Modeling of Soil Nutrient Assessment Programme (SNAP): Developing a Decision Support System for Sustenance of Soil Fertility in Humid Tropics of Kerala" with the Centre for Water Resources Development and Management (CWRDM), Kozhikode. In 2015 researchers from CWRDM visited IIASA to further develop the decision support system.
- "Livelihood Issues for Sustainability of Water Management" with the National Institute of Hydrology (NIH), Roorkee.

IIASA's researchers are collaborating with Indian institutions to identify smarter ways to manage India's land, soil, and water resources

IIASA's work is underpinned by high-quality science, which is regularly published in high impact publications. A selection of current publications is presented here; the full list can be found in Appendix 5.

- O'Neill BC, Kriegler E, Riahi K, Ebi KL, Hallegatte S, Carter TR, Mathur R, van Vuuren DP (2014). A new scenario framework for climate change research: The concept of shared socioeconomic pathways. *Climatic Change* 122(3):387–400.
- Pachauri S (2014). Household electricity access a trivial contributor to CO₂ emissions growth in India. *Nature Climate Change* 4(12):1073–1076.
- Skirbekk V, James KS (2014). Abuse against elderly in India – The role of education. *BMC Public Health* 14(1):336.
- Dholakia HH, Purohit P, Rao S, Garg A (2013). Impact of current policies on future air quality and health outcomes in Delhi, India. *Atmospheric Environment* 75:241–248.
- Rao ND (2013). Distributional impacts of climate change mitigation in Indian electricity: The influence of governance. *Energy Policy* 61:1344–1356.

**Selected publications
resulting from IIASA–Indian
collaborations**

Working with TIFAC, IIASA's agricultural and water specialists have also trained Indian researchers in their methods. A workshop took place at the Madras School of Economics in 2010 on land use planning with a focus on agriculture, one in 2011 at NIH on integrated water resource management for India's water-scarce Bundelkhand region, another workshop was run in 2012 at IRMA on adapting rural livelihoods to climate change, and a fourth with the Gujarat Institute of Development Research (GIDR), in Ahmedabad in 2013 on changing land use in India and developing data base and research methods to plan for this. In addition the planning of IIASA's new research area of food and water for 2011–2015 was greatly informed by a TIFAC and IIASA workshop in New Delhi in 2010.

IIASA's water and agricultural specialists have also:

- Researched, with the Indian Institute of Technology Kharagpur, the sensitivity of the agro-ecosystem in the Ganges basin to variations in rainfall.
- Analyzed the impact of new ways to manage water on the vulnerability of agriculture in India to climate change with partners including the Acharya N.G. Ranga Agricultural University.

India's Energy Future

India was a significant partner in and contributor to the Global Energy Assessment (GEA). Subsequently, the GEA's results have been extended to help provide a future global energy vision for India and identify policies to achieve universal access to clean, modern energy

The Global Energy Assessment (GEA), published in 2012, defines a new global energy policy agenda—one that transforms the way society thinks about, uses, and delivers energy. Coordinated by IIASA and involving over 500 specialists from a range of disciplines, industry groups, and policy areas, GEA research aims to facilitate equitable and sustainable energy services for all, in particular for around three billion people who currently lack access to clean, modern energy.

Indian researchers played key roles in the GEA, including its Co-Chair (Professor Anand Patwardhan, who was at the Indian Institute of Technology, Bombay at the time), four Convening Lead Analysts, and several Lead Analysts. Various GEA events also took place in India, including stakeholder consultations and presentations of the report's findings at the Clean Energy Ministerial meeting in New Delhi in 2013.

IIASA produced a synthesis report of the GEA's insights into providing access to modern forms of energy to the 1.4 billion today that still live without access to any electricity and the 3 billion who still depend on solid fuels such as unprocessed biomass, coal, or charcoal for cooking and space heating. The report had a focus on India and was part of an outreach workshop for policymakers in New Delhi in 2012 about global energy transformation pathways and policy tools organized with UNIDO, the Global Environment Facility (GEF), and The Energy and Resources Institute (TERI). IIASA's energy experts continue to explore the issues that link household energy use to poverty and climate change. Specific attention has been paid to analyzing policies in India to promote universal access to clean and affordable energy services.

The GEA examined some 40 future pathways to reach a future energy system that is sustainable, secure, and accessible to all. These energy scenarios were explored from India's perspective in collaboration with Integrated Research and Action for Development (IRADe), New Delhi, and sponsored by TIFAC. The project has helped provide a future global energy vision for India till 2050 and identify the energy transitions needed for sustainable development, including combating climate change.

The UN Secretary-General's Sustainable Energy for All (SE4ALL) initiative adopted findings from the GEA as its key objectives for energy access, energy efficiency, and renewable energy. IIASA and TERI are two of the leading institutions responsible for building up a global research and knowledge network for SE4ALL.

Subsequent IIASA studies have:

- analyzed the impact of growing household electricity access in India on the country's CO₂ emissions growth;
- developed a new method to evaluate the status and progress of rural household energy sustainability in India;
- investigated how increasing the tax on coal would help develop renewable energy in India;
- explored the potential, the costs, and the sustainability of second-generation biofuels in India.

Smart ways to clean up India's air

Current economic growth will intensify air quality problems in India unless current pollution control laws are significantly upgraded. By selecting a smart mix of measures to simultaneously cut air pollution and greenhouse gas emissions, countries can further reduce air pollution control costs in addition to cutting greenhouse gas emissions. IIASA's GAINS model is a scientific tool that has been helping policymakers and researchers across the globe to identify these measures.

IIASA has worked closely with The Energy and Resources Institute (TERI) in Delhi and other international partners to implement the GAINS model for Asia and for India. These versions of GAINS have underpinned various studies, including (1) an analysis of the effect of investments in clean air on human wellbeing in India (see box, *below*: IIASA's models, tools, and data); (2) how to improve ozone in South Asia; and (3) the first estimates of anthropogenic VOC (volatile organic compound) emissions in India.

With other partners the GAINS model was also used to:

- investigate climate-aerosol interactions in India;
- study how to control nitrous oxide emissions in a recent collaboration with the Indian Agricultural Research Institute among other partners; and
- assist Indian policy makers to design and implement practical policy interventions that lead to a phase-down in the consumption and production of hydrofluorocarbons (HFCs) with high global warming potential in cooperation with the Council on Energy, Environment and Water (CEEW) in New Delhi and supported by the ClimateWorks Foundation.

Training in GAINS has built capacity among researchers and policymakers in India to use the model to identify the costs and benefits of multiple measures to help clean up India's air. With support from TIFAC, workshops took place in Pune (2010), Ahmedabad (2011), and Nagpur (2012) with a significant number of policy leaders from India attending

Indian researchers and policymakers are working with IIASA to use its GAINS model to identify the most efficient and effective measures to tackle the country's air pollution

Through intense data gathering, computer modeling, and other advanced research methods, IIASA provides a country's researchers and their policymakers with the essential numbers and tools to select the most effective policies. For example:

- The air pollutant, fine particulate matter (PM_{2.5}), can travel far down into the lungs contributing to illnesses such as cardiovascular diseases, asthma, and lung cancer. Current levels of PM_{2.5} in most of India exceed the World Health Organization guideline of 10µg/m³ by more than a factor of four. And if the level of consumption of energy in India grows as expected, without additional air pollution controls, concentrations of PM_{2.5} in many parts of India will more than triple by 2030. However, if India implements advanced air pollution measures by 2030, life expectancy would increase by 2.8 years, and 2.5 million premature deaths per year would be saved. The costs of these new measures would also pay for themselves through the resulting health improvements which reduce lost work days and increase productivity. *Source*: IIASA's GAINS model. Research published in: Sanderson W, Striessnig E, Schoepp W, Amann M (2013). Effects on wellbeing of investing in cleaner air in India. *Environmental Science and Technology* 47:13222–13229.

Many of the research projects summarized in this Info Sheet draw on analyses from IIASA's models, tools, and data including:

1. Planning a sustainable energy system (MESSAGE model, Global Energy Assessment Scenario Database);
2. Reducing energy poverty (Energy Access Interactive Tool [ENACT]);
3. Improving food security through identifying yield gaps (GAEZ model) and assessing competition for land use between agriculture, bioenergy, and forestry (GLOBIOM model);
4. Financial disaster risk management (CATSIM model); and
5. Projecting future population (Demographic multistate modeling).

IIASA's models, tools, and data

(e.g., Member of the Planning Commission and Adviser to the Prime Minister on National Strategic Knowledge Mission on Climate Change; the former Secretary of India Central Pollution Control Board of the Ministry of Environment and Forestry).

Joint research with the Indian Institute of Management (IIM) in Ahmedabad and the Indian Institute of Technology in Kanpur (IITK) has explored the potential for improving energy efficiency in industry in India and the impact such measures would have on future emissions of carbon dioxide and air pollutants.

Finally, a new project, supported by TIFAC, in collaboration with the National Environmental Engineering Research Institute (NEERI) in Nagpur will develop the GAINS-City model for Indian cities. GAINS-City helps urban planners assess practical policy options for controlling urban air pollution that simultaneously maximize reductions in greenhouse gas emissions and minimize adverse health impacts due to air pollution.

Energy and climate change modeling

A collaboration between IIASA and the Indian Institute of Management in Ahmedabad is advancing energy and climate change modeling and better articulating the role of Asia and India in these studies

In 2010 Asia accounted for 60% of the global population, 39% of Gross World Product, 44% of global energy consumption, and nearly half of the world's energy system carbon dioxide emissions. Thus, Asia is an important region to consider in any discussion of climate change or climate change mitigation. IIASA worked with the Indian Institute of Management (IIM), Ahmedabad, and other partners to better articulate the role of Asia in mitigating climate change by comparing the results of 23 energy–economy and integrated assessment models. A journal special issue and a scenario database document the results of this study.

IIASA's global contributions

Many of today's most pressing challenges do not stop at international borders. IIASA's research areas such as climate change, water scarcity, and poverty are affected by multiple factors across the globe. In turn these global problems have impacts on nations, regions, and continents. Finding long-lasting solutions to these challenges requires scientific expertise that is free from the interests of a single nation. IIASA's National Member Organizations recognize this need and that their investment in IIASA is a contribution to a global public good. And the benefit of this contribution is paid back to global researchers, policymakers, and citizens in multiple ways, as the following examples show:

- IIASA supports the climate change research community by hosting the Representative Concentration Pathways (RCP) database. The database provides data on greenhouse gas emissions for four different future scenarios that underpin the analysis of thousands of climate change researchers. IIASA also calculated the data for one of the scenarios, all of which have been developed for the world's most comprehensive analysis of climate change—the IPCC's (Intergovernmental Panel on Climate Change) Fifth Assessment Report.
- IIASA's research provides scientific guidance to the Convention on Long-range Transboundary Air Pollution of the United Nations Economic Commission for Europe. This international environmental treaty between 33 countries has slashed air pollution in Europe, improving people's health and countries' crop production. IIASA's GAINS model guided negotiators and policymakers as they worked on the treaty to identify the most cost-effective approach to cleaning Europe's air. The negotiators chose the GAINS model not only because of its accuracy and usability but also because it had been developed by an international team with funding from multiple countries, which assured them that the model was nationally unbiased.

IIASA also collaborates with researchers from IIM in the:

- Energy Modeling Forum to learn from state-of-the-art developments in Integrated Assessment Modeling;
- EU funded project, LIMITS, on the co-benefits of climate policy for air pollution, energy security, and economic growth; and
- EU funded project, AMPERE, to explore climate change mitigation pathways.

IIASA has also collaborated with TERI among other partners to develop the Shared Socioeconomic Pathways (SSPs)—part of a new framework of scenarios that the climate change research community has adopted to facilitate the integrated analysis of future climate impacts, vulnerabilities, adaptation, and mitigation.

In 2015 climate change experts from IIASA and the Center for Policy Research (CPR) in Delhi started to ascertain India's future greenhouse gas emissions scenarios and climate mitigation impacts to help inform the Indian discussion over the country's contribution to a global agreement on climate that many hope will be negotiated at the UN Climate Change Conference in Paris in 2015.

Increasing India's resilience to natural disasters

Studies have assessed ways to improve proactive disaster risk management through

- comparing the management of landslide risks between India and Italy;
- retrofitting buildings against disaster risk;
- an empirical assessment of how well disaster micro-insurance has helped farmers to emerge from poverty traps following droughts, floods, and other extreme weather events;
- exploring how well poor households in Uttar Pradesh have rebuilt their lives since the devastating 1998 floods; and
- a case study of how Odisha dramatically reduced the impact of a 2013 tropical cyclone compared with a similar storm in 1999 through a range of risk reduction measures.

Indian research partners on these projects have included the All India Disaster Mitigation Institute, Gujarat; the InsPIRE Network for Environment, New Delhi; National Institute of Disaster Management (Ministry of Home Affairs, Government of India); and Gorakhpur Environmental Action Group. In addition, IIASA is collaborating with TIFAC to organize a conference in New Delhi in October 2015 on Integrated Disaster Risk Reduction: Challenges and Opportunities for Sustainable Growth. The above projects and conference have also brought in other IIASA research partners including the UK Department for International Development (DFID), The World Bank, and the United Nations Environment Programme (UNEP).

Key research findings include the most effective way to increase the resilience of poor households to extreme weather events is an integrated strategy that combines micro-insurance with physical adaptation measures. And that while a decentralized approach to managing landslide risk generates more conflict between stakeholders at a local level, this conflict is instrumental in leading to effective landslide governance and increasing the pace of implementation of risk reduction measures.

IIASA's risk and vulnerability team and a variety of Indian research collaborators have evaluated the risks posed to India by natural disasters including financial vulnerability to extreme weather events

Projecting India's future population

IIASA's demographers have been analyzing India's future population using the Institute's innovative methodology (multistate population projections) and training Indian researchers in its use

IIASA's demographers study and project the changing composition of population. The Institute's interdisciplinary setting has encouraged its demographers to research beyond the traditional boundaries of demography and to explore how changes in society, economy, and the natural environment influence the health and mortality, migratory patterns, and reproductive behavior of human society.

A recent innovative example of this broader approach has been the development of research methods to project population by level of education. This equips researchers with the tools to explore the implications of different education policies on a country's future fertility, life expectancy, migration, and population level as well as economic growth, transition to democracy, and ability to adapt to climate change. In 2014 IIASA published the first projections of educational attainment by age and sex for 195 countries with Oxford University Press. Findings for India show how different education policies over the next few decades could lead to a population of 1,131 million in 2100 which is declining or to a population of 2,687 million that continues to soar. Early findings were also published in the Asian Demographic and Human Capital Data Sheet 2012, which compared past, current, and future changing populations across all Asian countries.

Demographers from IIASA are currently extending these analyses by projecting the population of Indian States by not only age, gender, and level of educational attainment, but also by rural or urban residence. This research is part of a larger project to create a common platform of concepts and data to represent human social and economic heterogeneity in IIASA models.

IIASA and TIFAC organized two workshops in 2010 to train Indian researchers in IIASA's probabilistic population projection methodology. The first seminar in Mumbai was in collaboration with India's International Institute for Population Sciences. The second was in Bangalore with the Institute for Social and Economic Change (ISEC), whose Head of Population Research, K.S. James, is a long-term collaborator and regular visitor to IIASA. Additionally, in 2014 IIASA demographers in collaboration with ISEC and TIFAC organized an eight-day training workshop on demographic computations, in particular on multistate population projection models for demographic analysis in Excel and R in Bangalore.

Other recent demographic studies related to India include:

- A joint study with ISEC explored the role of education on the prevalence of abuse against the elderly in India;
- An investigation with the International Institute for Population Studies into the influence of older generation's fertility behaviors on daughter's desired family size in Bihar;
- An analysis of the impact of Buddhism on childbearing;
- IIASA's demographers are also researching the consequences of climate change on future human societies and examining the ability of those societies to cope with the coming changes in a major five-year study. The study, funded by the European Research Council, will inform policymakers of options available for climate adaptation and includes a case study on the adaptive capacity of India's Nicobar Islands; and
- Recent research with collaborators in the Indian Institute of Technology in Delhi on the coastal zones of India has explored if education plays an important role in improving local people's response to cyclone warnings.

Managing India's forests for the future

From 2007 to 2009 IIASA's forest researchers and collaborators in India, including TIFAC, conducted an in-depth analysis of Indian forests. It identified the key issues facing the forest sector and the policies to help it develop sustainably and meet future national needs. IIASA subsequently built on this research, in collaboration with the Indian Institute of Forest Management (IIFM) in Bhopal, to analyze forest carbon accounts for sustainable policy options as part of the India-IIASA Programme. The project focused on the implications for managing forest resources in Himachal Pradesh and Sikkim. It also had a capacity-building aspect with:

- a training workshop on ecological modeling—with special reference to the forest sector—at IIFM in 2010; and
- three Indian researchers spending several months in 2011 working with IIASA's researchers to apply IIASA's models and build national versions.

A further five-day workshop, in partnership with TIFAC and Jadavpur University, on "Accounting for Ecosystem Services: Theory and Practice" took place in May 2014.

Forest researchers from India and IIASA analyzed ways to develop India's forests sustainably, thereby ensuring the forests would meet future national needs

Business can benefit from science through the analysis and knowledge it provides. In turn, science can benefit from business through its experience on the ground and in implementation. IIASA also recognizes that closer collaboration between business and its researchers can increase the impact of the Institute's work. Not surprisingly, IIASA is seeing a growing number of contracts with commercial partners, including:

- The global insurer, **Zurich Insurance Group**, began working with IIASA in 2013 to identify and address research gaps on flood resilience and community based disaster risk reduction, demonstrate the benefits of pre-event risk reduction over post-event disaster relief and to improve public dialogue around disaster resilience.
- The German carmaker, **Daimler AG**, has collaborated with IIASA researchers to assess biofuel potential from marginal and degraded lands in India and Brazil.
- The Brazilian energy company, **Petrobrás**, was one of 19 sponsors of IIASA's Global Energy Assessment.
- The research institute of the Japanese carmaker, **Toyota**, has an ongoing collaboration with IIASA to research measures to reduce ozone emissions in Asia.
- The multinational consumer goods company, **Unilever**, funded IIASA's agricultural experts from 2008–2010 to analyze yields and land suitability of key agricultural crops under a changing climate.

In addition, IIASA is exploring ways that it can work more closely with multinational corporations, particularly through input to the development of their global sustainable business plans.

IIASA working with business

Other policy input

IIASA has advised India's Ministry of New and Renewable Energy and its chief climate negotiators

In addition to the interactions with policymakers as part of the research projects already mentioned in this Info Sheet, IIASA worked with the Ministry of New and Renewable Energy, Government of India. IIASA's researchers provided technical assistance to the Small Hydro Power Program of the ministry on the subsidy structure for small hydro power projects (< 5MW) in northeastern states of India.

While in Venice in 2012, IIASA experts advised chief climate negotiators and key modeling teams of the EU, USA, China, and India on the strengths and weaknesses of current greenhouse gas mitigation models.

Research to support science diplomacy

IIASA was established in 1972 to use scientific cooperation to build bridges across the Cold War divide and research growing global problems on a truly international scale. Today the soft power of science diplomacy continues to help IIASA's member countries through using scientific cooperation to improve international relations, and through international teams jointly researching controversial issues to find consensus such as through integrative assessments of the future for the Arctic or of the economic integration of Eurasia.

In addition, IIASA also maintains its original bridge-building objective through attracting member countries that represent a range of geo-political interests (see full list of members, *back page*). For instance, both Russia and the US are members, as are Brazil, China, India, and South Africa. Several key factors also unite all IIASA member countries: their interest in systems analysis, scientific and academic infrastructure, economic stability and the geopolitical role in future global transitions. With this in mind, IIASA is also discussing membership with countries in the Middle East including Israel, Iran, Jordan, Qatar, Saudi Arabia, and Turkey.

Capacity Building

Young Scientists Summer Program

IIASA's Young Scientists Summer Program (YSSP) develops the research skills and networks of talented PhD students. Program participants conduct independent research within the Institute's research programs under the guidance of IIASA scientific staff. Funding is provided through IIASA's National Member Organizations. Since 2007 the following 22 Indian students have participated in this program:

Since 2007, 22 Indian students have developed research skills and networks by taking part in IIASA's Young Scientists Summer Program

Samrat Chatterjee (YSSP'09) applied IIASA's CATSIM (CATastrophe SIMulation) model to analyze disaster risk financing strategies at a regional level. He was from the Punjab Engineering College in Chandigarh and at the time of his YSSP was studying Civil Engineering at Vanderbilt University in Nashville. (Funded by USA NMO, the National Academy of Sciences)

Hem Dholakia (YSSP'12) was studying for his PhD at the Indian Institute of Management, Ahmedabad when he joined IIASA's air pollution experts to evaluate how air pollution policies in Delhi and Mumbai will shape future air quality and health impacts in the city. (Funded by Indian NMO, TIFAC)

Sarthak Gaurav (YSSP'10) while studying for her PhD at the Indira Gandhi Institute of Development Research, Mumbai, conducted an analysis of the risk and vulnerability of water-stressed farm households in Vidarbha Region of India—an area that has witnessed a high incidence of farmer suicides in recent years. (Co-funded by Indian NMO, TIFAC, and IIASA)

Sapana Gupta (YSSP'09) from Raipur University carried out an assessment of Particulate Matter concentrations in India using the IIASA developed GAINS (Greenhouse Gas and Air Pollution INteractions and Synergies) integrated assessment methodology, which has been refined for application in Asia (GAINS-Asia). The assessment also involved a verification of the GAINS model. (Co-funded by Indian NMO, TIFAC, and IIASA)

Vithal Karoshi (YSSP'07), from the Yashwantrao Chavan Maharashtra Open University in Nashik, worked with IIASA's forestry experts to map and improve the estimates of the net carbon uptake from the atmosphere into vegetation, particularly forests. (Co-funded by Indian NMO, TIFAC, and IIASA)

Kalai Ramea Kubendran (YSSP'13), an Indian national studying for his PhD in the USA at the University of California, Davis, researched with IIASA's energy team to bring consumer behavior into one of the team's models that explores vehicle technology decisions (the MESSAGE-Transport model). (Funded by USA NMO, the National Academy of Sciences)

Abhishek Kumar (YSSP'14) investigated the influence of older generations' fertility and fertility preferences on the family size preferences of younger generations rural Bihar. He was studying for his PhD at the International Institute for Population Sciences when he took part in the YSSP. (Funded by Indian NMO, TIFAC)

Pallavi Marrapu (YSSP'11) was studying at the University of Iowa when she participated in the YSSP. She worked with the IIASA GAINS team to analyze the impacts of pollutant emissions on air quality and radiative forcing in South Asia. (Funded by USA NMO, the National Academy of Sciences)

Kapil Narula (YSSP'11) explored extending the modeling of decentralized, renewable-energy generation to include off-grid renewable energy options under the guidance of IIASA's energy experts. He was studying for his PhD at the Indira Gandhi Institute of Development Research in Mumbai at this time. (Funded by Indian NMO, TIFAC)

Architesh Panda (YSSP'11) was from the Institute for Social and Economic Change at the Centre for Ecological Economics and Natural Resources (CEENR) in Bangalore. Under the guidance of IIASA's risk and vulnerability researchers, Panda explored the vulnerability of farm households in western Orissa, India to climate variability and their adaptive capacity. (Co-funded by Indian NMO, TIFAC, and IIASA)

Praveen Kumar Pathak (YSSP'13) empirically explored the role of social networks in shaping fertility behavior of woman in rural India under the guidance of IIASA's demographers. Pathak is a PhD candidate at the International Institute for Population Sciences in Mumbai. (Co-funded by Indian NMO, TIFAC, and IIASA)

Anubhab Pattanayak (YSSP'12) worked with IIASA's risk and vulnerability researchers to characterize the sensitivity of Indian farmers' incomes to climate change. At this time, Pattanayak was a PhD student at the Madras School of Economics in Chennai, India. (Co-funded by Indian NMO, TIFAC, and IIASA)

Preeti Preeti (YSSP'10) conducted an analysis of future longevity increases in India and its major states with the objective of improving longevity forecasting in India. At the time, he was at the International Institute for Population Sciences, Mumbai. (Co-funded by Indian NMO, TIFAC, and IIASA)

Pushendra Rana (YSSP'08) assessed a conflict resolution approach that had been implemented in the Indian Himalayas to elicit better responses from local stakeholders in forest governance issues. At the time, he was with the Indian Forest Service. (Co-funded by Indian NMO, TIFAC, and IIASA)

Thiagu Ranganathan (YSSP'11) evaluated marketing strategies for farmers facing systemic yield risk, input credit repayment and liquidity constraints in the Dewas district of Madhya Pradesh under the mentorship of IIASA's risk and vulnerability researchers. He was studying his PhD at the Indian Institute of Technology, Bombay. (Co-funded by Indian NMO, TIFAC, and IIASA)

Soumya Rangarajan (YSSP'07), an Indian national who was studying at Harvard University, conducted a qualitative analysis of the socioeconomic and biological factors that have spurred the emergence of diseases, particularly influenza, in the Guangdong Province in China. (Funded by USA NMO, the National Academy of Sciences)

Shovonlal Roy (YSSP'07) from the Indian Statistical Institute worked under the guidance of IIASA's evolution and ecology experts to extend an evolutionary food web model to allow coexistence of two ecologically different species with approximately the same body size. (Co-funded by Indian NMO, TIFAC, and IIASA)

Selected presentations in or on India by IIASA researchers

Pavel Kabat on "Re-thinking Development" and **Nebojsa Nakicenovic** on "The Energy, Water, Food Triangle" at 14th Delhi Sustainable Development Summit in New Delhi (2014).

Shonali Pachauri on "GEA Scenarios for Universal Access" at a side event to the 4th Clean Energy Ministerial meeting in New Delhi (2013).

Günther Fischer on "Multi-scale Approaches for Global and National Climate Change Adaptation" at the TIFAC-IIASA-IRMA International workshop on Adapting Rural Livelihoods to Climate Change in Anand (2012).

Florian Kraxner on "REDD-PAC and Biodiversity" at COP11 of the United Nations Convention on Biological Diversity in Hyderabad (2012).

Fabian Wagner and **Pallav Purohit** on "Regional Air Pollution and Greenhouse Gas Mitigation" at the Center for Environmental Planning and Technology (CEPT), Ahmedabad and on "Economic Development and Atmospheric Pollution" at NEERI, Nagpur (2012).

Vegard Skirbekk on "Can Demographically Caused Human Capital Decline Be Offset by Human Capital Investments? Examples of China and India" at the Asian Population Association (APA) Conference in Bangkok (2012).

Arnulf Grubler on "Global Energy Assessment KM18 Urbanization: Summary and Main Findings" at the IPCC Expert Meeting on Human Settlements and Infrastructure in Kolkata (2011).

Stefan Hochrainer-Stigler and **Upasna Sharma** on "Mainstreaming Disaster Risk Reduction into Development Strategies" at the Sardar Patel Institute of Economic and Social Research (SPIESR) in Ahmedabad (2011).

David Wiberg and **Jan Sendzimir** on "Integrated Water Resources Management Strategy for Water Scarce Bundelkhand Region in India" at the National Institute of Hydrology in Roorkee (2011).

Hannes Böttcher, **Oskar Franklin**, and **Anatoly Shvidenko** on "Ecological Modelling" at the Indian Institute of Forest Management in Bhopal (2010).

Wolfgang Lutz on "Demography: International Perspectives and Challenges for India" at the International Institute for Population Sciences in Mumbai (2010).

Detlof von Winterfeldt, **David Wiberg**, and **Michael Obersteiner** on "Water Management and Sustainability" at TIFAC in New Delhi (2010).

Monika Sawhney (YSSP'08) researched the levels of development required in the areas of health, fertility, and education for developing countries to achieve the Millennium Development Goals. She was a doctoral student at Tulane University in New Orleans, having graduated with two Masters from India. (Funded by USA NMO, the National Academy of Sciences)

Angan Sengupta (YSSP'12) came from the Institute for Social and Economic Change in Bangalore, India, to take part in the YSSP. Under the guidance of IIASA's demographers, he explored how education policies will impact India's future population and whether a demographic dividend would emerge. (Co-funded by Indian NMO, TIFAC, and IIASA)

Niharika Tripathi (YSSP'14) from the International Institute for Population Sciences explored preferred life-expectancy and its correlations among elderly women in Uttar Pradesh. (Funded by Indian NMO, TIFAC)

Navarun Varma (YSSP'09) from the TERI University Institute of Policy and Planning, New Delhi, applied a systems approach to model how responses of communities with varying vulnerabilities to change are connected across scales (local–national) using data from coffee farmers in Mexico and Vietnam (1985–2005). (Co-funded by Indian NMO, TIFAC, and IIASA)

Nancy Wozabal (YSSP'08) studied the performance of different measures of risk in the setting of disaster management under the guidance of IIASA's risk and vulnerability team. At the time she was pursuing her PhD at the University of Vienna after receiving her Masters from the Indian Institute of Technology Bombay. (Self-funded)

Regional Young Scientists Summer Program

In 2012 IIASA launched its first regional YSSP—the Southern African Young Scientists Summer Program (SA-YSSP), organized jointly by the South African National Research Foundation, the South African Department of Science and Technology, the University of the Free State in Bloemfontein, South Africa, and IIASA. The following Indian nationals have participated in the program:

Six Indians have taken part in the regional Young Scientists Summer Program in South Africa

Arnab Banerjee (SA-YSSP'14/15, Visva-Bharati University) developed a model to study the variation of certain physico-chemical factors and plants on the dynamics of a reservoir.

Shelly Bogra (SA-YSSP'14/15, TERI University) studied the physical, economic and policy implications of the Indian water-energy-material nexus.

Joyita Mukherjee (SA-YSSP'12/13, Visva-Bharati University) analyzed measures of robustness in aquatic ecosystems.

Mayank Prakash (SA-YSSP'14/15, International Institute for Population Science) explored water-sanitation-hygiene-related morbidity and its socioeconomic impact on the slum dwellers of Mumbai.

Tejas Rawal (SA-YSSP'14/15, Indian Institute of Technology, Roorkee) researched how to plan a sustainable transportation system in Kanyakumari District, Tamil Nadu.

Fatima Sumbul (SA-YSSP'13/14, Aligarh Muslim University) explored governance in water management during the SA-YSSP.

Postdoctoral Program

Postdoctoral researchers at IIASA work in a rich international scientific environment alongside scientists from many different countries and disciplines. The Institute's research community helps its postdoctoral researchers to develop their research from fresh angles, to publish widely in journal articles, and to establish their own global network of collaborators. Three postdoctoral fellows from India have participated in the program since it began in 2006:

Three postdoctoral fellows from India have developed their research and published widely at IIASA

Narasimha D. Rao (2011–2013) researched the relationship between electricity access, livelihoods, and carbon dioxide emissions in India. His methods included economic simulation models of the electricity sector and social welfare, input–output analysis, and carbon accounting. His work emphasized modeling policy and institutional influences such as supply rationing and energy subsidies. He has used his analysis to project the impacts of different urban and rural consumption patterns on carbon emissions. (PhD in Environment and Resources [September 2011] from Stanford University, California, USA)

Upasna Sharma (2009–2011) researched issues related to the communication of uncertainty associated with climate forecasts and climate hazard warnings, particularly, how the target audience of these forecasts and warnings interpret, understand, and respond to uncertainty. Collaboration on micro-insurance in India between IIASA and Sharma has followed since she returned to India where she is now researching at the Indian Institute of Technology in Delhi. (PhD in public policy and climate change [2009] from the School of Management at the Indian Institute of Technology, Bombay)

Tapas Mishra (2007–2008) studied the consequences of stochastic demographic systems on economic growth and development by exploiting their non-stationary temporal and spatial features. (PhD in Economics [2005] from the Catholic University of Louvain, Belgium)

Other capacity-building activities

IIASA and TIFAC have held 19 training workshops for Indian researchers and policymakers in India since 2007

Apart from the 13 training workshops mentioned elsewhere in this Info Sheet, IIASA and TIFAC have also organized workshops on:

- Forest management in New Delhi (2007)
- Land use and land use change at the Planning Commission (2007)
- Mathematical modeling at the National Institute of Science, Technology & Development Studies (NISTADS) in New Delhi (2009)
- Disaster risk reduction at the Sardar Patel Institute of Economic and Social Research (SPIESR) in Ahmedabad (2011)
- Indian perspectives on global energy scenarios (2011)
- Indian participants in the Young Scientists Summer Program at TIFAC (2013).

IIASA participates in MSc European Forestry, a masters training program for advanced university students. As part of the program successful candidates work for a three-month period with IIASA researchers to further their studies. Two Indian students have participated in the program since 2005.

Quick facts on IIASA interactions with India

- Nearly 150 Indian nationals have participated in IIASA events since 2008.
- 168 publications have resulted from collaborations between IIASA and Indian nationals since 2008.
- On average 9 Indian nationals have been employed by IIASA every year since 2008.
- Since 2007, 22 Indian nationals have gained international and interdisciplinary research experience from participating in IIASA's Young Scientists Summer Program, 6 took part in the Southern African Young Scientists Summer Program, and 3 were IIASA Postdoctoral Fellows.
- Over 50 researchers, advisors, and diplomats from India have visited IIASA since 2008, while IIASA scientists have visited India nearly 90 times.

Appendices

The details behind the above facts can be found in the following appendices to this Info Sheet. The appendices are either attached or available on request from Sanja Drinkovic (drinkovs@iiasa.ac.at):

1. Employees with Indian nationality at IIASA (2008–2015)
2. Indian visitors to IIASA (2008–2015)
3. Conference participants from India to IIASA (2008–2015)
4. Travel by IIASA scientists to India (2008–2015)
5. Publications relevant to Indian–IIASA collaborations (2008–2015)

Prospects for Future IIASA–Indian Activities

This Info Sheet summarizes recent research collaborations and capacity building activities between IIASA and India. Significant potential remains to further intensify the IIASA–India relationship through developing a range of new joint activities including:

Enhancing Indian expertise in applying system analysis to national problems

Developing bespoke Indian versions of IIASA's global models would allow researchers and policymakers to look at complex global problems and their impact on India in a holistic and integrated way. For example, the Dutch government worked with IIASA to develop a Dutch version of the IIASA GAINS model. The new model helps ministries to identify cost-effective measures to improve air quality and reduce greenhouse gas emissions in the Netherlands at the same time as complying with the country's obligations under international air quality agreements.

Conducting international assessments in areas of Indian strategic interest

Indian researchers contributed to IIASA's Global Energy Assessment which brought together over 500 specialists to transform the way society thinks about, uses, and delivers energy. IIASA is embarking on four new future assessments, at the request of its member countries. Two will focus on issues of strategic interest to India: holistic, integrative assessments of plausible futures for global water challenges and tropical forests.

Academic training opportunities for young Indian scientists Numerous doctoral students have developed research skills in systems analysis by participating in the Young Scientists Summer Program and the Southern African version (see page 13: Capacity Building). There is potential to further enhance participation by young Indian scientists by, for example, becoming a partner in IIASA's forthcoming International School of Excellence.

New partnerships between IIASA and Indian institutions to win grants from international research funders IIASA's high-quality research and international research network makes it highly competitive in its applications for international research funds. Between 2006 and 2014, IIASA almost doubled its income by winning research grants that amounted to €69 million. This was part of a total funding portfolio of €329 million of the external projects in which IIASA was and is involved. For example, researchers from IIASA, the Indian Institute of Technology Bombay and Winrock International India worked jointly on the Risk to Resilience project funded by the UK's Department for International Development, which shows the potential for Indian researchers to collaborate with IIASA to access funds from third parties.

Using international scientific cooperation to support diplomacy IIASA was established in 1972 to use scientific cooperation to build bridges across the Cold War divide and research growing global problems on a truly international scale. Today the soft power of science diplomacy continues to help IIASA's member countries through using scientific cooperation to improve international relations, and through international teams jointly researching controversial issues to find consensus, free from the constraints of national self-interest (see box, page 12: Research to support science diplomacy). Recently, IIASA has launched a new international project to analyze the prospects for economic integration between Europe and the countries of the former USSR.

Enhancing the IIASA–Indian relationship offers benefits for Indian research, government policy, and international relations

About IIASA

Founded in 1972, the International Institute for Applied Systems Analysis (IIASA) conducts policy-oriented research into problems of a global nature that are too large or too complex to be solved by a single country or academic discipline. IIASA's research areas are energy & climate change; food & water; and poverty & equity.

IIASA is at the center of a global research network of around 2,500 scholars and over 550 partner institutions in over 65 countries. It is funded and supported by its National Member Organizations which represent the scholarly community in the following countries:

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

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