Proceedings
of the Late Summer Workshop
Young Scientists Summer Program 2012

23-24 August, 2012

Edited by Olha Danylo
IIASA’s annual 3-month Young Scientists Summer Program (YSSP) offers research opportunities to talented young researchers whose interests correspond with IIASA’s ongoing research on issues of global environmental, economic and social change. From June through August accepted participants work within the Institute’s Research Programs under the guidance of IIASA scientific staff.

The Proceedings of the Late Summer Workshop constitute summaries of the research results obtained during Young Scientists Summer Program and presented in a workshop at the International Institute of Applied Systems Analysis, Laxenburg, Austria, 23-24 August, 2012. The proceedings receive only limited review and are not for publication in the current form. Views or opinions expressed herein do not necessarily represent those of the Institute, its National Member Organizations, or other organizations supporting the work.

This compilation contains all the summaries available at the time of finalization of the proceeding.
## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program</td>
<td>4 - 6</td>
</tr>
<tr>
<td>Summaries</td>
<td>8 - 41</td>
</tr>
<tr>
<td>Poverty &amp; Equity</td>
<td>8 - 18</td>
</tr>
<tr>
<td>Energy &amp; Climate Change</td>
<td>19 - 28</td>
</tr>
<tr>
<td>Advanced Systems Analysis</td>
<td>29 - 32</td>
</tr>
<tr>
<td>Food &amp; Water</td>
<td>33 - 41</td>
</tr>
<tr>
<td>Author Index</td>
<td>42 - 43</td>
</tr>
</tbody>
</table>
### Thursday, 23 August 2012

**Welcome and Introduction by YSSP Dean Joanne Bayer (Wodak Room)**

<table>
<thead>
<tr>
<th>Time</th>
<th>Participant</th>
<th>Topic</th>
<th>Room</th>
<th>Topic</th>
<th>Chair</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:00 – 09:10</td>
<td>Welcome and Introduction by YSSP Dean Joanne Bayer</td>
<td>Welcome and Introduction by YSSP Dean Joanne Bayer</td>
<td><strong>WODAK Room</strong></td>
<td><strong>ENERGY &amp; CLIMATE CHANGE</strong> Resource/Energy Efficiency Modeling</td>
<td>Jens Borken-Kleefeld</td>
</tr>
<tr>
<td>09:10 – 09:35</td>
<td>Vijay Limaye</td>
<td>Refined Dose-Response Functions for Small Particulates: A Health Impact Analysis in GAINS-Asia</td>
<td><strong>WODAK Room</strong></td>
<td>Kei Kabaya MAG Impact assessment of energy efficiency improvements in the residential sector in Japan</td>
<td><strong>GVISHIANI Room</strong></td>
</tr>
<tr>
<td>09:35 – 10:00</td>
<td>Kyeongah Nah</td>
<td>The evolution of malaria incubation time</td>
<td><strong>WODAK Room</strong></td>
<td>Fangyi Li ENE How can China meet its energy intensity target</td>
<td><strong>GVISHIANI Room</strong></td>
</tr>
<tr>
<td>10:00 – 10:25</td>
<td>Collin Payne</td>
<td>The Role of Education in the Aging Process in a Lowest-Income Context: Health Transitions and Health Expectancies in Malawi</td>
<td><strong>WODAK Room</strong></td>
<td>Yadong Yu ASA Construction of an Optimal Model for Resource Productivity in China</td>
<td><strong>GVISHIANI Room</strong></td>
</tr>
<tr>
<td>10:45 – 11:10</td>
<td>Anubhab Pattanayak</td>
<td>Poverty, Risk, and Climate Change in Rural India: Characterizing Sensitivity of Farming Communities to a Changing Climate</td>
<td><strong>WODAK Room</strong></td>
<td>Hiroto Shiraki ASA Enhancements of AIM energy system model aimed at providing robust solutions for mitigation of future climate change</td>
<td><strong>GVISHIANI Room</strong></td>
</tr>
<tr>
<td>11:10 – 11:35</td>
<td>Hem Dholakia</td>
<td>Assessment of future air quality and health impacts in Delhi and Mumbai</td>
<td><strong>WODAK Room</strong></td>
<td>Marliis Lehtveer ENE Multi-Criteria Analysis of the Role of Nuclear Power in the Global Energy System</td>
<td><strong>GVISHIANI Room</strong></td>
</tr>
<tr>
<td>11:35 – 12:00</td>
<td>Angan Sengupta</td>
<td>Educational Change and its Impact on Fertility and Demographic Dividend of Future India</td>
<td><strong>WODAK Room</strong></td>
<td>Stephen Healey TNT An analysis of the dynamics of environmental energy technologies</td>
<td><strong>GVISHIANI Room</strong></td>
</tr>
</tbody>
</table>

**Break**

**Welcome and Introduction by YSSP Dean Joanne Bayer (Wodak Room)**

<table>
<thead>
<tr>
<th>Time</th>
<th>Participant</th>
<th>Topic</th>
<th>Room</th>
<th>Topic</th>
<th>Chair</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:30 – 13:55</td>
<td>Danielle Nel</td>
<td>Public Private Partnerships in South African renewable energy sector: an integrated assessment</td>
<td><strong>WODAK Room</strong></td>
<td>Yuche Chen MAG High Emitting Vehicles: Identification, relevance, and policy strategies</td>
<td><strong>GVISHIANI Room</strong></td>
</tr>
</tbody>
</table>

**Break**
<table>
<thead>
<tr>
<th>Time</th>
<th>Name</th>
<th>Organization</th>
<th>Topic</th>
<th>Chair</th>
<th>Location</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:55 -</td>
<td>Sebastian Busch</td>
<td>RPV</td>
<td>Towards a framework for sharing the benefits of deploying renewable</td>
<td>Olha Danylo</td>
<td>ESM</td>
<td>Spatial inventory of greenhouse gas emissions in the residential</td>
</tr>
<tr>
<td>14:20 -</td>
<td>Jung Hun Lee</td>
<td>EEP</td>
<td>Curbing Corruption in Public Good Games</td>
<td>Christoph</td>
<td>ENE</td>
<td>Energy Demand Scenarios for the Transport Sector</td>
</tr>
<tr>
<td>15:00 -</td>
<td>Sam Hyun Yoo</td>
<td>POP</td>
<td>Educational differentials in completed fertility in Korea</td>
<td>Dilip Khatriwada</td>
<td>ESM</td>
<td>Optimizing ethanol and bioelectricity production in sugarcane</td>
</tr>
<tr>
<td>15:25 -</td>
<td>Ki-Chul Choi</td>
<td>MAG</td>
<td>Development of Source-Receptor Relationships over South Korea in</td>
<td>Karol Opara</td>
<td>ASA</td>
<td>Modelling biodiesel reactor I</td>
</tr>
<tr>
<td>15:50 -</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ASA</td>
<td>Modelling biodiesel reactor II</td>
</tr>
<tr>
<td>16:30 -</td>
<td>Kathleen Bohan</td>
<td>ENE</td>
<td>Development of energy security constraints for MESSAGE based on national</td>
<td>Firdos Khan</td>
<td>WAT</td>
<td>Assessment of Water Flow in the Indus River and Management of Water</td>
</tr>
<tr>
<td>16:55 -</td>
<td>Maragatham Kumar</td>
<td>MAG</td>
<td>Assessment of Air Pollution and GHG Mitigation Strategies in Malaysia</td>
<td>Taiki Fuji</td>
<td>EEP</td>
<td>Effects of climate-induced changes in river flows on Japanese</td>
</tr>
<tr>
<td>17:20 -</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>EEP</td>
<td>A Management Model for Alpine Fish Populations under Temperature Stress</td>
</tr>
<tr>
<td>Time</td>
<td>Room</td>
<td>Session Title</td>
<td>Chair</td>
<td>Speaker(s)</td>
<td>Topic</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------</td>
<td>----------------------------------------------------</td>
<td>------------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>09:00 – 09:10</td>
<td>WODAK Room</td>
<td>Welcome and Introduction by YSSP Scientific Coordinator Brian Fath</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:10 – 09:35</td>
<td>WODAK Room</td>
<td>Ecological Networks</td>
<td>Chair: Brian Fath</td>
<td>Morag Ayers (ASA)</td>
<td>Ecosystem robustness to overfishing: do community modules play a role</td>
<td></td>
</tr>
<tr>
<td>09:35 – 10:00</td>
<td>GVISHIANI Room</td>
<td>Forest Modeling</td>
<td>Chair: Oskar Franklin</td>
<td>Victoria Veshchinskaya (EEP)</td>
<td>Forest management scenarios and their implications for land use, carbon balance and ecosystem service supply in Sweden and abroad</td>
<td></td>
</tr>
<tr>
<td>10:00 – 10:25</td>
<td>WODAK Room</td>
<td>Information network analysis for Dam-induced Eco-risk Assessment</td>
<td>Shaoqing Chen (ASA)</td>
<td>Alexander Laletin (ESM)</td>
<td>Ecological and economical accessibility assessment of forest resources</td>
<td></td>
</tr>
<tr>
<td>10:25 – 10:45</td>
<td>Break</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:45 – 11:00</td>
<td>WODAK Room</td>
<td>Robustness and Disasters</td>
<td>Chair: Elena Rovenskaya</td>
<td>Syed Ali AsjadNaqi (RPV)</td>
<td>Understanding Coping Mechanisms and Poverty Traps in Extreme Events: A Multi-agent Simulation Experiment</td>
<td></td>
</tr>
<tr>
<td>11:10 – 11:35</td>
<td>WODAK Room</td>
<td>Robustness and resilience in water resources planning: towards well-prepared adaptation in a changing climate</td>
<td>Lan Hoang (RPV)</td>
<td>Pheakkdey Nguon (ESM)</td>
<td>Reducing emissions from deforestation: explaining stakeholders’ perceptions on REDD+ policy</td>
<td></td>
</tr>
<tr>
<td>11:35 – 12:00</td>
<td>WODAK Room</td>
<td>Exploring human-environmental networks using the ecological network approach</td>
<td>Ali Kharrazi (ASA)</td>
<td>Tobias Nielsen (RPV)</td>
<td>Applying Cultural Theory to the Emerging Policy Scheme on Reducing Emission from Deforestation and forest Degradation (REDD+)</td>
<td></td>
</tr>
<tr>
<td>12:00 – 13:30</td>
<td>Break</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>Speaker Name</td>
<td>Chair</td>
<td>Title</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>--------------</td>
<td>-------</td>
<td>----------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13:30 - 13:55</td>
<td>Zhuoran Liang</td>
<td>WAT</td>
<td>Assessment of climate change impacts on the potential productivity of major crops in China using a fusion model system based on AEZ and DSSAT models</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13:55 - 14:20</td>
<td>Debra Perrone</td>
<td>WAT</td>
<td>Exploration of Historical Water Demand Trends in the US</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14:20 - 14:45</td>
<td>Emma Jonson</td>
<td>ESM</td>
<td>Connecting regional land use modeling and data to global scenarios</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15:00 - 15:25</td>
<td>Stefan Schreier</td>
<td>ESM</td>
<td>Estimates of forest fire NOx emissions in Russia between 1998 and 2010</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15:25 - 15:50</td>
<td>Sarah Evans</td>
<td>EEP</td>
<td>What mechanisms explain soil carbon dioxide flux under fluctuating rainfall patterns</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Biogeochemical Cycles**
Chair: Christina Kaiser

**Land Use Change I**
Chair: Anatoly Shvidenko (or Hannes Boettcher)

**Land Use Change II**
Chair: Anatoly Shvidenko (or Hannes Boettcher)

**Break**

**End of Workshop**

**Reception at Schloss Restaurant**
Refined Dose-Response Functions for Small Particulates: 
A Health Impact Analysis in GAINS-Asia

Vijay Limaye
University of Wisconsin-Madison
Email: vlimaye@wisc.edu

Introduction: Small particulate matter (PM$_{2.5}$, diameter 2.5 microns or less) is implicated as the most damaging pollutant to human health because it can bypass the natural defense systems of our bodies (e.g., coughing, sneezing, and swallowing) and penetrate into the bloodstream. The Greenhouse Gas-Air Pollution Interactions and Synergies (GAINS) model was developed as a tool to identify emission control strategies that maximize synergies between the control of local air quality and mitigation of greenhouse gas emissions, with considerations made for human health impacts. Most long-term epidemiological studies of the relationship between exposure to PM$_{2.5}$ and premature mortality have been conducted in developed countries, where ambient concentrations commonly range between 5-30 µg/m$^3$[1]. However, levels of PM$_{2.5}$ in developing countries such as India commonly exceed this range. The Global Burden of Disease (GBD) Assessment of the World Health Organization posits refined dose-response functions for specific causes of early death. These functions follow an exponential decay model consistent with a biological saturation hypothesis for PM$_{2.5}$ health impacts, as the risk of disease increases at a slower rate at high concentrations. The revised functions contrast with the linear form of the current all-cause mortality function. This work applies the posited functions to air pollution scenarios in India to explore consequences for health impact analysis in GAINS.

Methodology: Estimates of relative risk (RR) for specific causes of early death associated with ambient PM$_{2.5}$ exposure in India for natural emissions, and in 2020 and 2030 business-as-usual scenarios were derived using the GBD functions. The dose-response relationship was approximated linearly between these three points. Estimates of statistical life expectancy (SLE) were calculated based on the piecewise risk estimates with baseline mortality rates for India. Cumulative months-of-life lost were aggregated and weighted based on age-adjusted national mortality rates for each specific cause of disease. Estimates of Years of Life Lost (YOLL) in each Indian state were calculated using population estimates (age 30 and above) within GAINS.

Results: Under the GBD dose-response assumptions, the average loss in SLE of 32.5 months (standard error 1.4 months), compared to a range of 36.0-53.7 months currently estimated in GAINS. Impacts on SLE range from 8.5 months (Andaman and Nicobar) to 42.0 months in Delhi. Cumulatively, 1.1 billion YOLLs can be attributed to chronic PM$_{2.5}$ exposure in the above-30 group nationwide.

Conclusion: Application of the new functions resulted in health impact estimates that approximate current GAINS output, with added information about cause-specific outcomes. While the revised functions theoretically favor pollution mitigation in areas with relatively low baseline pollution levels, results show that per-µg/m$^3$ health impacts are nearly uniform across the country. Cause-specific estimates could help inform public health interventions, and these methods likely underestimate the total health burden caused by PM$_{2.5}$ exposure due to model assumptions on age thresholds.

The evolution of malaria incubation time

Kyeongah Nah

Supervisor: Rupert Mazzucco

Co-supervisor: Ulf Dieckmann

Abstract:

Malaria is one of the most dangerous infectious diseases, responsible for a significant fraction of human deaths in a large part of the world. Yet, past eradication efforts have failed. To design effective eradication campaigns, the infection cycle must be well understood. Malaria’s infectious agents (parasites of one of several species of the genus Plasmodium) are transmitted between mosquitos and humans through mosquito bites: after transmission, symptoms occur only after a certain incubation period. In particular, Plasmodium vivax – the malaria-inducing parasite species most prevalent in temperate zones – remains dormant in the human liver for longer periods than other species, which makes its combatting especially difficult. While incubation periods of P. vivax malaria in Korea show a clearly bimodal distribution, with short-term and long-term incubation periods, the reasons for this bimodality are not known. Using adaptive dynamics theory, we study the evolution of incubation times and investigate the evolutionary constraints guiding the emergence of bimodality.
The Role of Education in the Aging Process in a Lowest-Income Context: Health Transitions and Health Expectancies in Malawi

Collin F. Payne  
University of Pennsylvania  
Email: collinp@sas.upenn.edu

Introduction. A substantial body of contemporary research has found a strong relationship between formal education and adult health and mortality in the developed world. However, the form of the education-health relationship is less well known in developing settings, particularly in sub-Saharan Africa (SSA). Though the current age structure is quite young, the aging population in SSA will grow proportionately more rapidly than any other segment of the population (fig. 1), and by 2060, persons aged 45+ will be about 25% of the total SSA population. By 2030, chronic non-communicable diseases are expected to cause 47% of deaths in Africa, compared with only 27% in 2008 (WHO 2008). Understanding the correlates of health among this growing population may provide useful information in predicting trends in health and the planning of health care provisions, particularly as the current health infrastructure in SSA is focused mainly on communicable disease and the younger population (Beard et al. 2012).

Methodology. I use data from three waves of the Malawi Survey of Families and Households (MLSFH) to estimate annual probabilities of entering into physical disability and death by age, sex, and educational attainment. I then estimate the number of years that the average individual will live in active and disabled life by generating synthetic cohorts of individuals via microsimulation, and analyzing the resulting disability trajectories. I test several exogenous factors that could confound the education-health relationship.

Results/Conclusions. I find that individuals in SSA experience substantial disability and that individuals with more education are less likely to transition to disability and death. However, education is not significantly associated with recovery from stays in disability. Males with 4 or more years of education live on average 3 years longer than males with less than 4 years of education, with all of these additional years lived in active life. Females with more education do not live longer overall, but do live proportionately more of their lives without disabilities. My findings show that increasing educational attainment in SSA could contribute substantially to increasing life expectancy and reducing the disability burden in this society.

References
Poverty, risk and climate change in rural India: characterizing sensitivity of farming communities to a changing climate

Anubhab Pattanayak
Madras School of Economics, Chennai, India
Email: anubhab.pattanayak@gmail.com

Introduction. Indian agriculture is highly climate sensitive and poses serious threat towards the large sub-populations who are dependent on this sector for their livelihood. Based on existing research on the climate sensitivity of Indian agriculture (Kumar and Parikh, 2001; Sanghi et al., 2008), the present study attempts to characterize the nature and extent of sensitivity of income accruing to different sub-sections of the farming community towards climate change.

Methodology. In the first stage, using cross-sectional data pooled over the period 1966-1986 and multivariate regression approach, the study estimates the climate response function of cultivator net-revenue across 271 Indian districts. Cultivator net-revenue and its loss for a range of IPCC-AR4 projected climate scenarios are estimated using the climate response function. The second stage of the analysis uses a household level survey data to estimate the loss in income due to climate change. Since net-revenue from farming forms a significant portion of cultivator income, the average loss in income is estimated using the long-term net-revenue obtained from the first stage. The analysis estimates loss in income across different groups of cultivator households which are formed based on size of land-holding. Further, difference in climate sensitivity of income for farmers resorting to irrigation vis-à-vis those without irrigation is estimated.

Results. Average decline in cultivator net-revenue across all districts for the range of climate scenarios considered varies from -7 to -23 percent. The average loss in income with a 2-degree Celsius rise in temperature across cultivator groups varies between -8 and -23 percent. Marginal and large farmer’s income is more sensitive towards climate as compared to farmers with small and medium land-holding. Within each group of cultivators, loss in income for households with irrigation varies between -6 to -16 percent whereas the same for households without irrigation varies between -12 to -26 percent. For households with and without irrigation the decline in income for marginal and large cultivators is more severe as compared to the small and medium cultivator households.

Conclusions. The micro-level analysis of the study reflects the vulnerability of the farming community’s income towards climate change. Within farming community the vulnerability varies across households. Climate sensitivity of income across cultivator groups has a threshold effect with high sensitivity for marginal and large farmers. Irrigation across all groups helps reduce the sensitivity of income towards climate shocks.

References
Future air quality and health impacts assessment in Delhi and Mumbai

Hem H. Dholakia
Indian Institute of Management, Ahmedabad, India
Email: hemdholakia@iimahd.ernet.in

**Introduction** - Outdoor air pollution levels in Indian megacities such as Delhi & Mumbai greatly exceed the recommended national ambient air quality standards (CPCB, 2010) leading to adverse health impacts. Though city specific policies across diverse sectors (e.g. industry, power, transport etc.) have been legislated to curb air pollution, a systematic evaluation of their efficacy is lacking. The objective of this study is to evaluate the current portfolio of city specific policies to understand how they will shape future air quality and health impacts thereof in Delhi & Mumbai.

**Methodology** – The city specific policies (CSP) for Delhi and Mumbai were implemented in the Greenhouse Gas & Air Pollutants Interactions and Synergies (GAINS) model to estimate future concentration levels for particulate matter (PM2.5). These policies included control strategies for mobile transport (road and non-road), industry, power sector, waste management as well as switches in fuel use (e.g. public transport buses moving from diesel to compressed natural gas). The CSP were compared to an alternate scenario (ACT) where stringent measures to control air pollution (comparable to those available in industrialized nations) were implemented. For both these scenarios, health impacts were calculated as the statistical loss in life expectancy (Mechler, Amann & Schoepp, 2002).

**Results** – In the year 2030, air quality does not reach the recommended standard in Delhi and Mumbai if city specific policies continue in the future (Figure 1). Application of stringent controls currently available in the market substantially reduces air pollution impacts in Indian cities. However, even under these conditions, the recommended standards are not achieved in Delhi. The loss in statistical life expectancy is about half under ACT as compared to CSP in 2030 (Figure 2).

![Figure 1. PM$_{2.5}$ Concentrations (ug/m$^3$)](image1.png)

![Figure 2. Loss in statistical life expectancy (months)](image2.png)

**Policy implications** –
1. Current policy legislation is not adequate to bring down air pollution in Indian cities in the future.
2. Adoption of advanced control technologies alone is not enough to meet National ambient air quality standards unless they are done in conjunction with land-use change and fuel shifts to renewable energy.

**References**
CPCB (2010). Air quality monitoring, emission inventory and source apportionment studies for Delhi: New Delhi: Central Pollution Control Board.
Educational Change and its Impact on Fertility and Demographic Dividend of Future India

Angan Sengupta, Research Scholar,
Institute for Social and Economic Change, Bangalore, India.
School of Public Health and Primary Care (CAPHRI), Maastricht University, The Netherlands
Email: angan.and@gmail.com

Introduction: Debates are floating around the emergence of demographic dividend and the potential of this working age population to bring an overwhelming economic growth. The optimists are enthusiastic over the country’s large young population and bright economic prospect, whereas the pessimists are worried about poor health and education status of the people.

Objective: The main objective of my research is to project and explore the effect of educational attainment on age-sex composition for the Indian population given different scenarios during 2001-51 and thus to understand the potential of the demographic dividend to capture the economic growth. The two scenarios are: (1) Proportion of population across education groups remains constant over the years and (2) the proportion in higher education increases over time.

Data and Methodology: The data for the proposed study has been drawn from various sources. The population data has been taken from the Census of India, while the age and education specific fertility and mortality data collected from the Sample Registration System of India (SRS) and the ongoing Oxford-IIASA population projection, respectively. We have followed the assumptions from the same Oxford-IIASA project in order to avail the projected level of educational attainment across various age groups in India. To achieve this objective we have used the multi-state population projection technique focusing upon educational attainment in India to understand the age-sex composition

Results and Conclusions: Considering the interesting fact that for the last decade the fertility has not gone down in most of the educational groups in India, except among those who are either illiterates or have not completed their primary education, the Total Fertility Rate (TFR) will go down from 3.05 in 2001 to 2.27 in 2021 and will remain stagnant for rest of the period while the education completion rate does not improve from that of 2006. But while the completion rate increases regularly over the years, India may expect a fall in fertility rate to 2.08 in 2051. It will touch the below replacement level at somewhere around 2041-2046, much beyond what the policy suggests. The ratio of working age population to the total population shows a significant improvement once the educational profile improves and we consider that the productivity will be higher for those who are better educated, which in turn means that the better capital formation and lesser pressure on the state as a whole resulting to a fruitful demographic dividend. Nevertheless, education has a long momentum and hence, India will be handicapped by past and present low investments in education, though the rapid fertility decline along with educational improvement would definitely prove to be beneficial for the India.
South Africa’s hoped-for transition from fossil fuels to renewables: an assessment of Independent Power Production

Danielle Nel
University of Johannesburg
Supervisor: Dr. Nadejda Komendantova
Co-Supervisor: Prof. Michael Thompson
Email: DNAcademe@gmail.com

South African (SA) power supply is highly centralised, with a state owned and monopolistic utility Eskom producing 95% of overall electricity supply and 93% of it is generated by coal-fired power stations. Although SA contributes to only around 1% of the world’s greenhouse gas emissions, in per capita terms, it is one of the globe’s dirty nations. Unsurprisingly, a switch away from fossil fuels and towards renewables is now seen as essential if the country is to adapt to the environmental, social and economic challenges that are presented by climate change. Independent Power Producers (IPPs) are a form of competitive government procurement through outsourcing, which will leverage private capital, thereby significantly reducing the burden that this inevitably expensive transition would otherwise place on the public deficit. IPPs will also be public private partnerships, as the outsourcing done by government involves Eskom, who buys energy from the IPP. So, two questions arise. Firstly, will IPP be successful in effecting the transition from fossil fuels to renewables. Secondly, will they be successful in attracting private capital, thereby realising the transition to renewables without placing an undue burden on the public deficit. This study investigates whether IPPs increase or decrease systemic risks in the development of renewable energies in SA, in order to do so, the perceptions of systemic risks by stakeholders are assessed. This study deduces preliminary results from case studies of public private partnerships for infrastructure development in SA to learn lessons from government outsourcing. New Public Management (NPM) theory is used as a conceptual framework to assess the quality of governance in outsourcing in SA. In addition, cultural theory is applied as a methodological framework to understand risk perceptions of stakeholders. The following risks were assessed, technology, legislation changes, design, reputational, shareholder, high cost of lending, construction, operational, political, human capacity, corruption, regulation and institutional risk. As quantitative results from surveys show four types of risks are perceived as most serious and likely to happen, these are corruption, political, human, construction and operational risks. Qualitative results indicate that systemic risks include the immaturity of the market, intergovernmental relations, lack of knowledge, understanding and awareness of stakeholders supplemented by the governance gaps such as transparency, effective financing and lending, distribution and delivery of electricity, access to electricity, intergovernmental relations, lack of experience, procurement challenges, lack of planning and decision making, land site issues, interest and exchange rate risks. The analysis and inter-comparison of qualitative and the quantitative results showed a correlation between finance and lending, political and human capacity risk. Cultural theory assessment indicates that the individualist and hierarchical solidarity feature strongly, the fatalist solidarity is present, however, the egalitarian solidarity does not feature prominently. The research suggests that government encourage all types of organisation and encourage all types of organisation.
Towards a framework for sharing the benefits of deploying renewable energies across borders: possible contributions from cooperative game theory

Sebastian Busch
TU Wien
E-mail: busch@eeg.tuwien.ac.at

Overview. Directive 2009/28/EC on the promotion of the use of energy from renewable sources has introduced a stable legislative framework laying down individual mandatory targets for the share of renewable energy in final energy consumption for each Member State whilst allowing Member States to decide on the most cost-efficient technology path and support scheme to achieve those targets. The various discussions on the importance of the stability of support schemes and the need for somewhat differentiated approaches corresponding to the resources and market development in different regions, have resulted in an agreement that more effort should be put into cooperation and coordination of schemes rather than harmonisation. As a result the current directive contains a set of three mechanisms, allowing for cross-border support of energy from renewable sources amongst two or more countries. These differ in their scope for cooperation in terms of commitment and complexity of institutional set-up, thus giving the member states the flexibility to pick a model for cooperation corresponding to their needs and priorities. The mechanisms available are, Statistical Transfers, Joint Projects and Joint Support Schemes.

Several studies have highlighted how the use of the cooperation mechanisms can create benefits, such as reduced costs of target compliance. The legal framework for such trade is established; the economic and fiscal rational is strong, and yet little use is made of the mechanisms. One important barrier that has been identified is that there exists no commonly agreed on and considered satisfactory methodology to allocate the costs and benefits of deploying renewable energies among the member states making use of a cooperation mechanisms.

Methods. Cooperative game theory (CGT), to a lesser extent cost-benefit analysis, energy system analysis

Results. The following results can be expected:

• An Identification of barriers and limitations of currently discussed approaches of cost / benefit sharing in the context of the use of the cooperation mechanisms.
• A case study of applying CGT to an exemplary implementation of a cooperation mechanism.
• An identification of implications from applying CGT in the context of the cooperation mechanisms, involving:
  o An analysis of the cooperation mechanisms in cooperative game form.
  o An evaluation of different solution concepts from CGT with regards to their suitability in the application context.
• A conclusive discussion, on how CGT can contribute to set up a methodology for sharing costs / benefits of resulting from the use of the cooperation mechanisms.

Conclusions. The research in this paper is motivated by issues of policy implementation. Therefore it addresses a specific barrier that regards the implementation of the cooperation mechanisms of the EU renewables directive, i.e. the question how costs and benefits of deploying renewable energies can be shared across member states. The results suggest that CGP is generally applicable to the problem and that methods based on CGT have advantageous over commonly suggested methods. There is no shortage of plausible methods for cost allocation. The essence of the problem, however, lies not in defining methods, but in formulating principles and standards that should govern allocation, and then determining methods which satisfy them.
Curbing corruption in public good games

Jounghun Lee
Kyushu University
Email: traum98s@bio-math10.biology.kyushu-u.ac.jp

Although the “tragedy of commons” is ubiquitous, field researches on the governance of commons and laboratory experiments of public good games show that sometimes cooperation can be maintained and the tragedy avoided (Ostrom, 1990; Rutagi et al., 2010). Ostrom claims that the basic design principles for systems allowing long lasting resource use include the successful establishment of a monitoring and sanctioning system (Ostrom, 1990). This is in line with theoretical studies emphasizing punishment as a mechanism to enforce cooperation (Nakamaru and Iwasa, 2006; Rockenbach and Milinski, 2006; Nakamaru and Dieckmann, 2009). Corruption may arise when monitoring and sanctioning is delegated. It is a significant problem that disturbs ecosystem management in many places, such as forest management in Cambodia, Indonesia, Tanzania, etc. The phenomenon occurs widely and persistently at state and community levels (Corbridge and Kumar, 2002; Véron et al., 2006; World Bank, 2006). It ruins joint efforts, and leads to resource depletion and distorted distribution. Previous theoretical studies deal with corruption between harvesting firms and public inspectors (Mishra, 2006; Diarra and Marchand, 2011).

To study the evolutionary dynamics of the spread of corruption and its suppression, here we consider the situation that a group of players establishes monitoring and sanctioning institutions which are run by hired rule enforcers. This approach is in line with a study showing that social learning can lead to the adoption of institutions (Sigmund et al., 2010). We assume that the group must provide funds for the rule enforcer. We diversify the way of funding and observe its effect to the dynamics of the corruption.

References
Educational Differentials in Completed Fertility in Korea

Sam Hyun Yoo
E-mail: samhyun.yoo@asu.edu

Abstract:

South Korea has experienced one of the fastest fertility declines in the world in recent decades. During the same period, female educational attainment has also improved considerably. The objective of this study is to understand the process of fertility decline in Korea since the mid-20th century, to identify the contribution of female education to the decline in cohort fertility, and to estimate further change in the near future.

Based on Korean Census data, specifically 1% samples of the raw data between 1970 and 2010, completed cohort fertility for the birth cohorts of 1926-70 and educational differentials in union-formation and childbearing behavior are analyzed.

The results show that completed fertility has declined continuously since the 1926 birth cohort, but that the pace of decline slowed once completed cohort fertility dropped below replacement level around the 1960 birth cohort.

Educational differentials in completed fertility, which was about 2.8 children between the highest and lowest education levels, decreased steadily and all but disappeared for the latest cohorts. As a result, compositional change in female education just accounts for only about 19.8% of the decline in cohort fertility between the 1926 and 1970 birth cohorts, while change in fertility behavior explains about 80.2% of the decline.

The decline of cohort fertility in Korea since the mid-20th century is mainly attributable to behavioral change rather than structural change in female education. This suggests that during the 1960s to 1980s the efforts for birth control in Korea (e.g., family planning program and its campaigns through the media) were quite successful in reaching all social strata of the population. Nevertheless, female education may have continued to contribute to fertility decline though indirect ways, for example by facilitating the spread of contraceptive use and new norms of family size from high to low educated women.

Based on education-specific trends in marital status, parity progression ratios, and population composition, completed cohort fertility is projected to decrease further for the birth cohorts of 1971-85, and the progression ratio from one to two children to become an important determinant of completed cohort fertility. However, the projected drivers by themselves do not appear to be able to explain the very low levels of period fertility observed in the meantime.
Development of source-receptor relationships (S-R) over South Korea in support of GAINS model

Ki-Chul Choi
Konkuk University, Seoul, Korea
Email: choiki@iiasa.ac.at

Introduction. Air quality models (AQM) are usually used to predict ambient concentrations, such as ozone and particulate matter (PM), at multiple spatial and temporal resolutions. Control strategies have been designed and evaluated using regional air quality models to understand impacts of emissions reduction. Understanding the contributions to specific receptor locations from particular emission sources or chemical pathways helps develop effective emissions control strategies. For the IIASA’s GAINS-Asia model S-R estimations have so far been performed for China and India only. In this study, source receptor relationships were developed for South Korea using the regional AQMs.

Methodology. In order to estimate the contributions to ozone, the CMAQ ozone & precursor tagging methodologies (OPTM) (Douglas et al., 2009) source apportionment tool were applied in this study. The OPTM, known as tagging methodology differs from sensitivity simulations in the model in which the emissions are modified or eliminated such as brute force method. OPTM provide the contribution information for each emission sources, relative to the unmodified simulated conditions. This method is the tracer-based techniques that extra tagged species added to a grid model to track ozone or its precursors from specific sources. For ozone, aggregate modeled species are defined to track oxidant, nitrogen oxides (NOx), and volatile organic compounds (VOCs) and used to track species. These techniques are useful evaluation tools to identify which source categories or source regions contribute to receptor ozone concentrations. For estimate S-R relationships, I divided South Korea into six source-receptor regions and 4 source categories.

Results. Contributions from outside of Korea domain to monthly averaged ground ozone (April, 2008) for S. Korea show more than 85%. For each receptor regions, more than 60% impacted by external regions except the model boundary effects. However, contribution rates can be changed by temporal resolutions and seasonal characteristics. Figure 1 shows the contribution of NOx and VOCs emissions from source regions to monthly averaged ozone for S. Korea

![Figure 1. Contribution of emissions from source regions to monthly averaged ozone for S. Korea (Apr. 2008)](image_url)
Impact assessment of energy efficiency improvement in the residential sector in Japan

Kei Kabaya
Institute for Global Environmental Strategies, Japan
Email: kabaya@iges.or.jp

Introduction
Energy consumption in the residential sector in Japan has been increased considerably for the last few decades due to population growth and higher living standards, which now occupies approximately 16 percent of total final energy consumption in Japan. Considering that Japanese industrial sectors have already achieved higher energy efficiency standards, it will be required to investigate the potential of energy efficiency improvement in the residential sector and assess its effects on CO2 emission with a view to achieving certain emission reduction targets.

Methodology
The GAINS model developed by MAG program can illustrate above research questions, however, it has a few issues to be considered in terms of Japanese energy pathways. Energy statistics currently incorporated in the GAINS model as a reference considerably differs from that based on domestic information and the efficiency measures currently adopted are basically assessed based on information obtained from another countries. Here in this study, one new dataset on energy consumption, efficiency measures, and their penetration and costs was developed on the basis of Japanese domestic information, with taking into account certain regional circumstances, for more robust estimates for future energy consumption and CO2 emission in the residential sector.

Results
The new dataset demonstrated different results from those the reference scenario has indicated between 2005 and 2030. Energy consumption in the residential was continuously decreased until 2030 while the reference scenario showed increase in energy use from 2010. Reflecting these trends, the GAINS model with the new dataset illustrated opposite future CO2 emission in the residential sector in Japan. Earlier uptake of efficiency measures led to further CO2 emission reduction, so accelerated electrification in the residential sector did. As its co-benefits, less fuel use in residential sectors and less coal combustion for electricity generation contributed to NOx and SO2 emission reduction, which may result in less health problems.

Conclusion
Since different statistics and information may lead to different results, it will be essential to reflect local conditions and circumstances in the model. Consequently, this research should be expanded to include commercial, industry and energy generation sectors to assess total national potential for emission reduction.
How can China meet its energy intensity targets?

Fangyi Li
Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China
Graduate University of Chinese Academy of Sciences, Beijing 100049, China
Email: fyli1985@gmail.com

Introduction. The relationship between economic growth and energy consumption has always been a hot topic in energy-related research, also a very complex one. Income of the family is one of the determinants. On the one hand, income exerts a large influence on the implicit energy used by the household when purchasing household appliances; on the other hand, it also affects the level of energy consumption via the income elasticity parameter: the higher the income, the higher the energy consumption (Druckman and Jackson 2008; Feng, Zou et al. 2011). At the 2009 Copenhagen conference, China pledged to reduce its carbon intensity (defined as a reduction in CO2 per unit of GDP) by 40%-45% till 2020 compared with that of 2005. Based on the long-term target, a target was set in the 12th five years plan, which is 16% of reduction in energy intensity. There are two methods to reduce energy intensity, structural shift and energy efficiency improvement. This research will figure out how much shift or improvement is needed for energy intensity reduction, considering rapid increase of consumption and GDP.

Methodology. Consumption is a base for analysis of structural shift, which is projected through trend extrapolation method. After that we use linear programming to find an optimize way to guide structural shift. Linear programming is a mathematical method for determining a way to achieve the best outcome (such as maximum profit or lowest cost) in a given mathematical model for some list of requirements represented as linear relationships. We also built different scenarios to estimate the reduction of energy intensity, including basic case, fixed efficiency scenario and fixed structure scenario.

Results. In basic case, it is impossible to meet the target without structural shift and efficiency improvement. In efficiency-fixed scenario, production should be shift from manufacturing to service sectors, as shown in Table 1. If structural shifts are constrained, it need 12% improvement in energy efficiency in all sectors or up to 43% improvement in energy intensity if the improvement occurs in only the top 10 energy intensive sectors. If structural shifts can cause at least 13% of reduction in energy intensity, pressure on efficiency gain will be much less.

Table 1 Structural shift to meet energy intensity target without efficiency gain

<table>
<thead>
<tr>
<th>Sector</th>
<th>2005-2010</th>
<th>2010-2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>55%</td>
<td>47%</td>
</tr>
<tr>
<td>Mining and processing of resources</td>
<td>82%</td>
<td>9%</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>129%</td>
<td>21%</td>
</tr>
<tr>
<td>Construction</td>
<td>207%</td>
<td>3%</td>
</tr>
<tr>
<td>Transport, Storage, post</td>
<td>76%</td>
<td>34%</td>
</tr>
<tr>
<td>Service sectors</td>
<td>103%</td>
<td>115%</td>
</tr>
</tbody>
</table>

Conclusions. The energy intensity target is too high to meet if there is no structural shift or efficiency improvement. It is feasible through structural shift alone and within recent historical bounds. If structural shifts are constrained, it need 12% improvement in energy efficiency in all sectors or up to 58% improvement in energy intensity if the improvement occurs in only the top 5 energy intensive sectors.

References
Optimal Control Model of Resource Productivity for Sustainable Economic Development

Yadong Yu
Advanced System Analysis Program, International Institute of Applied System Analysis
E-mail: artonry@gmail.com

Introduction. Nowadays, natural resources is a critical factor for economic development, and the economic growth theory is facing challenges while addressing the issue of resources naturally constrained by the total reserve. It is urgent to explore new approaches in economics, in which resource management will be a central point. This paper aims to testify whether it is possible by raising resource productivity and substitute old resource (raw materials) by new materials obtained in technological progress in order to get sustainable development.

Methodology and results. We use optimal control theory with combination of economic growth model to study the problem. By construction and modification of an optimal control model, the relationships among resource consumption, economic output, consumption, R&D investment, and resource productivity as well as their dynamics are reflected.

The optimal control problem for the R&D investment process is posed and solved within the Pontryagin maximum principle. Sufficient conditions for specific range of the model parameters are indicated providing the existence result for the steady state of the Hamiltonian system which is interpreted as the stationary optimal solution.

Calibration of the parameters and analysis of the variables are made, and existence of steady state of the model are verified. Results show that discount rate should be increased to be more than 0.17 to guarantee the existence of steady state, which indicates that it is possible by raising resource productivity and substitute old resource (raw materials) by new materials obtained in technological progress in order to get sustainable development.

Sub-optimal transition trajectory is constructed by logistic curve as one scenario to show how the economic system can transform from the current state to steady state. Four main results are: (1) the economy will get to steady state by 2092 if the error tolerance is 1%; (2) the average annual growth rate of GDP is 4.45% during 2008-2092; (3) the economy will witness a maximum resource consumption in 2029 before running out of resource; (4) by logistic transition trajectory of R&D investment intensity, the target (15%) proposed for resource productivity in the 12th Five-Year Plan can be achieved if GDP/DEU is chosen as the indicator.

Conclusions. It is possible by raising resource productivity and substitute old resource by new materials obtained in technological progress in order to get sustainable development.

References


Enhancements of AIM energy system model aimed at providing robust solutions for mitigation of future climate change

Hiroto Shiraki
University of Tokyo, Tokyo, Japan
Email: h.shiraki@kanies.k.u-tokyo.ac.jp

Introduction. To support decision making and future policy aimed at climate change mitigation, diverse energy system models are being developed. Some of such models base on engineering and inter-temporal optimization and compute an optimal greenhouse gas emission trajectory, as well as technology selection options. Because such models run under deterministic optimization methods with perfect foresight, they usually present unrealistic optimal solutions. To mitigate these problems, users introduce various constraints and run diverse scenario trying to find more realistic results. Such results are however based on user definitions and preferences, therefore are not robust. The approach to be presented aims at improving the AIM model, developed by National Institute for Environmental Studies.

Methodology. The energy system model is enhanced by two types of modifications. First, initial investments for energy extraction sector are incorporated. For this enhancement, the capacity and the initial cost of energy extraction sector are introduced explicitly. Since the model runs to minimize total system costs, increase/decrease of energy consumption is determined endogenously with consideration of investment recovery. Second, uncertainties of future energy service demand are introduced. To compute optimal technology selection and energy composition under uncertainties, the stochastic model which is incorporated new variables for undershooting costs and costs of backstop technologies are developed.

Results. Initial investments for energy extraction sector: drastic decrease of coal energy supply is mitigated by consideration investment recovery. Uncertainties of future energy service demand: optimal technology selection and energy composition under uncertainties are calculated by stochastic energy system model. Compare to sum of the total system cost calculated by deterministic model and the costs of undershooting supply under deterministic solution, the total system cost calculated by stochastic model is small.

Conclusions. In this study, the AIM model was improved by two approaches. Integrated analysis of the enhanced model provides robust solutions that not only contribute to mitigation of future climate change, but also have desired characteristics of the trajectories.

References
Spatial inventory of greenhouse gas emissions in the residential sector

Olha Danylo
Lviv Polytechnic National University
Email: olha.danylo@gmail.com

Introduction. Residential sector has a great potential for greenhouse gas (GHG) emissions reduction comparing to other sectors, especially in developing countries. In order to assess the potential for energy efficiency improvement in this sector the easy-to-use tool for spatial-distributed GHG emissions inventory is needed.

Methodology. Based on fossil fuel consumption, population density, household living conditions and other available statistics data the universal approach, algorithms and mathematical models for spatial inventory of GHG emissions in the residential sector at the level of elementary objects (settlements or it’s parts) are developed. The proposed approach of emission inventory of GHG gases in residential sector consists of: dividing investigated area for elementary objects of specified size; performing inventory of GHG emissions for every elementary object. Based on performed numerical experiments the geo-referenced databases and digital maps of GHG emissions in Poland, as an example of EU Member State, and Ukraine, as example of non-EU Member State, are obtained. Due the analysis of obtained results the major GHG emission sources for selected regions are identified. Analysis of emission processes is conducted for elementary areas 2 km x 2 km in size.

Results. Poland. According to the obtained results of GHG spatial inventory in the residential sector the largest GHG emissions are observed in Polish cities, especially in Southern Poland. The specific GHG emissions from burning coal are the largest in Warsaw, Katowice and Krakow and in the surrounding areas. Around 30% of total GHG emissions in residential sector in Poland are emitted in Slaskie and Mazowieckie Voivodeships. In all Voivodeships the total amount of GHG emissions from burning coal in CO2-equivalent exceeds the total amount of GHG emissions from burning other fuels.

Ukraine. The total amount of GHG emissions from burning natural gas in Ukraine exceeds the total amount of GHG emissions from burning other fuels. In Donets’k and Luhans’k regions the high amount of GHG emissions from burning coal as compared to other regions are observed. Donets’k, Kyiv, and Dnipropetrovs’k regions emit over 25% of total GHG emissions in the country.

Conclusions. As the developed approach is flexible based on the available input data, it may be implemented in other countries in order to assess the amount of GHG emitted to the atmosphere. The practical importance of the developed spatial-based approach and GIS-based software consists in its usefulness for analyzing, optimization and planning the environmental protection measures.

References
Energy Demand Scenarios for the Transport Sector
Christoph Bertram
Potsdam Institute for Climate Impact Research
Email: bertram@pik-potsdam.de

Introduction. Integrated Assessment Models (IAMs) tend to have a bias towards detail on the supply side of the energy system [1]. Nevertheless, many studies with IAMs indicate that energy efficiency improvements at the end-use side can play a large role in future climate change mitigation scenarios. This project aims to close this disconnect by examining in depth how the inclusion of detail in the end-use technologies into the modeling framework affects the results of a model. For this study, the transport sector was chosen, due to both its high and rising share of final energy use and the availability of simple models to simulate consumer choice of end-use technologies.

Methodology. We use the integrated assessment model MESSAGE-Macro [2], developed and operated by the Energy Group (ENE) of IIASA, and incorporate a detailed transport sector representation developed for a standalone MESSAGE-enduse version, that features 5 different person transport modes and one freight mode, each with various technology and fuel options. We adapt the MESSAGE-Macro coupling and update the baseline (no climate policy reference scenario) demand projections for person transport. As a first step, we use a convergence approach [3], [4] to get to total travel demands. For the mode shares we use a logit sharing approach [5], [6] that takes technology and fuel prices and the mode speeds into account. We run scenarios with the standard setup with aggregate end-use representation and the novel setup with the detailed transport sector, each without and with exponentially increasing carbon taxes (starting at 10 and 30 US$/tCO2 in 2020 respectively, and increasing at 5% p.a.)

Results. The detailed modeling setup produces plausible results in terms of absolute travel demand response and mode shift induced by the carbon tax. The two model versions show different fuel use patterns for the transport sector. The dominant difference is that the uptake of electricity as transport fuel happens much faster in the aggregate model version.

Conclusions. The results of the detailed model version show that electric transport technologies have to be scaled up very fast (> 15% p.a. over several decades) in order to arrive at the maximum useful energy shares of 40% and 75% that have been used in the conventional and advanced transport sector setup of the Global Energy Assessment scenarios [1].

References
Modelling biodiesel reactor: kinetics of reaction and phase equilibria

Karol Opara, Pin Pin Oh

Biofuels can contribute to mitigation of climate change. To enhance their competitiveness in the energy mix one needs to optimize its production process. A promising approach is to replace conventional, batch reactors with continuous-operation membrane ones. To make the latter effective, significant amount of modeling and experimental work is needed. A prototype of a membrane biodiesel reactor is currently being built in Malaysia. The two key modeling elements are the kinetics model of reaction and phase equilibrium study.

Kinetics model of reaction describes its speed and extent and is given by a system of ordinary differential equations. Fitting it to the experimental data is a nonlinear optimization task. We analyze impact of different error measures on the fit quality. The analysis is visualized in a graph depicting the landscape of fit errors and comparing it with literature results for similar reactions. We show that changing the typically used mean squared error to mean absolute deviation or the “mean of root error” enhances the robustness of the solution.

Biodiesel is produced from oil and alcohol. As the oil and alcohol are immiscible, the mixture will form a two phase system of oil-rich phase and alcohol-rich phase. Developing a model of the reactor requires knowledge of the distribution of the six chemical components present in this reaction between both phases. This can be done with a Non-Random Two Liquid model (NRTL). Identification of this model requires addressing several challenges, including: a small sample of experimental data for estimating 45 parameters, inconsistency of the experimental data with rules governing the kinetics of the reaction, high cost and effort required to collect experimental data, as well as high non-linearity and non-convexity of the model. We focus on exploiting the kinetics model of the reaction for building a large and coherent representation of data out of the small and inaccurate sample. This representation is then used to identify parameters of the NRTL model. We show that such approach contributes to both better estimation of parameters and extending the boundaries of applicability of the NRTL model to multicomponent mixtures.
Assessment of Water Balance and Management at Tarbela Reservoir under Different Climate Change Scenarios

Firdos Khan
Global Change Impact Studies Centre, National Centre for Physics (NCP) Complex, Quaid-i-Azam University Campus, Islamabad, Pakistan.
Email: fkyousafzai@gmail.com

Introduction: Water resources play an important role in agriculture, energy, industry, households, and ecological balance. In Pakistan, ninety percent of agriculture depends on the Indus River System (IRS). There is high uncertainty in the availability of water in the river due to the variability of the monsoon, western disturbances, prolonged droughts and melting of glaciers in the Himalaya-Karakorum-Hindu Kush (HKH) region. Therefore, proper management of water resources is undeniably important. Due to the growing population, urbanization and increased industrialization, the situation is likely to get worse.

Methodology: In this study we are using UBC watershed model to make projections of inflow to Tarbela Reservoir. Upper Indus Basin (UIB) having latitude from 34° N to 37° N and longitude 72° E to 79° E is chosen for the proposed project. The total area of upper Indus basin is 162,393 square kilometers. PRECIS (climate model) output is used as input data to the hydrological model. The main variables are maximum temperature, minimum temperature and precipitation. Direct use of the output of climate models cannot be encouraged to use as an input to hydrological model for impact studies (Haerter, 2011). Different techniques have used for temperature and precipitation to remove the bias from the RCM data. In order to use a hydrological model to make scenarios for inflow it necessary to calibrate it first. For calibration of the UBC (Hydrological Model) we used land-use data, soil data and historical meteorological data. After calibration of the model can be used to make projections of inflow. In the last we investigated that what will be the situation of water availability at Tarbela reservoir during 2010-2039 under A2 scenario.

Results: It is observed from the analysis that the maximum and minimum temperature is increasing about 1.70 °C over UIB, Pakistan during 2010-2039. The precipitation is increasing almost by 64 percent over the region under study during 2010-2039 under A2 scenario. During calibration we achieved almost 90 % efficiency of the UBC model at UIB, Pakistan. For calibration we have used meteorological data for the period 1995-2004 and for validation we used the data for the period 1990-1995. The projections of inflow to Tarbela reservoir show that overall 55 % inflow increasing to Tarbela Reservoir during 2010-2039. It is important that there will be much more water available in the future i.e. 2010-2039 under A2 scenario for most of the time. Only for 18 months there will be shortage of water, for 212 months there will be more water than enough and for the remaining period there will sufficient water available at Tarbela Reservoir during 2010-1039 under A2 scenario. An interesting result is that the shortage of water is mostly observed in the winter season i.e. in the months of January, February, March, April.

Conclusions: Climate is changing at UIB in the future. Maximum and minimum temperature and precipitation is increasing during 2010-2039 under A2 scenario. The inflow to Tarbela Reservoir is also increasing during the same period. It is also noted that there will be shortage of water for some small amount of time but for most of the time there will be more water available during 2010-2039 under A2 scenario at UIB, Pakistan.

References
Effects of climate-induced changes in river flows on Japanese seabass
Taiki Fuji
Kyoto University, Japan
Email: taiki@kais.kyoto-u.ac.jp

Introduction. Climate changings and anthropogenic impacts are increasingly altering the native environment of many fishes. Developing sustainable fisheries-management practices that are capable of mitigating the effects of these changes require a good understanding of the mechanisms driving the dynamics of fish populations and their interactions with the changing environment. The water temperature and river discharge are the environmental factors that is important for coastal fish ecology and could be affected by climate changings. We developed and analyzed a model of the population dynamics of Japanese seabass Lateolabrax japonicus which is commercially important in Japan to predict how this species will be affected by the anticipated degradation of river nurseries and changes in river discharge brought about by human activities.

Methodology. This model focused on the survival schedule in the early life stage (first year of their life) and introduced the relationships between the environmental factors (river discharge and temperature) and the mortality of Japanese seabass larvae and juveniles. The model calibration was conducted by minimizing the sum of squares between historical catch data (n=55) and model results.

Results. The model could reconstruct the historical fish catch data (n= 55, R²=0.53). Sensitivity test revealed that temperature was the main driver for population dynamics and river discharges have relatively small effects. Climate changing simulation revealed that temperature rising by global warming would increase the seabass population considerably, although the river discharge change occurring with the global warming would limit the population increasing.

Conclusions. Temperature was the main driver of the population dynamics of Japanese seabass and it would increase by global warming in the future.
A management model for Alpine fish populations under temperature stress
Harald Ficker
Institute for Limnology of the Austrian Academy of Sciences, Mondsee, Austria & Department of Organismic Biology, Paris Lodron University, Salzburg, Austria
Email: harald.ficker@hotmail.com

Introduction The Alpine lakes are home to stenothermic coldwater fishes, such as economically important whitefish species (Salmoniformes: Coregonidae: Coregonus spp.). Many populations are subject to fishery management interventions, which affect population densities, survival rates, and recruitment through stocking and harvesting. In addition to artificially induced life history changes, environmental variables and most of all habitat temperature modify somatic growth, survival and fecundity (Pauly 1980). One example of an exploited whitefish population under temperature stress is the population of the Alpine Lake Irrsee, which showed a strong decline in abundance in the late 1990s but recovered in the last ten years due to intensified stocking and reduced harvesting by fishermen. Continuous warming of cold deepwater habitats has already been proved for several Alpine lakes in the area of Lake Irrsee (Dokulil et al. 2006) and could supplementary affect population dynamics. In this study, we develop a length-structured matrix model for a whitefish population and implement management interventions (angling and stocking) as well as temperature dependent survival to test how different habitat temperatures could change trajectories of exploited whitefish populations.

Methodology In general, matrix models describe demographic development over discrete time steps (e.g., months or years) and discrete life-history stages (e.g., length classes), which are characterized by two specific vital rates (reproduction and survival). Length-structured matrix models move individuals to the next length class depending on their somatic growth rates. Such transition probabilities between length-classes were derived for our matrix model (55x55 matrix, 1cm length classes) from a biphasic and variable growth function fitted to length-at-age data of a 10-year catch series by gillnets in Lake Irrsee (N = 2,013). In addition, we calculated continuous functions of fecundity, maturation and length-weight relationship and used them together with sex ratio and egg-mortality estimates for the definition of specific reproductive rates of each length class. The temperature dependent survival was incorporated by utilizing the empirical formula developed by Pauly (1980) for the generation of three different temperature scenarios (observed temperature, +1°C, +2°C). Furthermore, we tested different egg-mortality probabilities, which are considered to increase under warmer habitat temperatures. Finally, harvesting and stocking by the angler association of Lake Irrsee were incorporated by subtracting respectively adding numerical vectors of fish with specified length at each time step over the ten year simulation period.

Results The results produced by the population model showed that the whitefish population of Lake Irrsee would become extinct after 8.25 years if the annual catch by anglers is as high as the mean annual catch over the last ten years. Fish stocking together with harvesting produced an increase in population biomass under observed habitat temperatures from 5.08°C to 6.17°C and associated annual survival probabilities (S_a) from 0.67 to 0.70. The same matrix model setup with consideration of +1°C (6.08°C to 7.17°C, S_a = 0.64 to 0.67) and +2°C (7.08°C to 8.17°C, S_a = 0.62 to 0.65) reduced the growth in population biomass by approximately 30% and 50%, respectively. We observed the strongest impact on population dynamics by slightly increasing egg mortalities, which could cause a strong decline in whitefish abundance and biomass.

Conclusion Our results showed that stocking is essential for sustainable population growth and a profitable fishery by anglers in Lake Irrsee. The temperature dependence in annual survival probabilities revealed that small reductions in fish survival induced by a warmer lake habitat can produce lower population growth. This should be considered in management actions for coldwater fish species to ensure sustainable harvesting and population conservation. Due to our modeling results, we think the strong effect of egg mortalities on population dynamics needs more attention by fishery biologist and should be investigated more precisely in the future, especially with consideration of temperature effects.

References
Ecosystem robustness to fishing: do community modules play a role?

Morag Ayers
University of KwaZulu-Natal, Durban, South Africa
Email: moragayers@gmail.com

Robustness is an important trait of ecosystems particularly of marine ecosystems which are subjected to increasingly frequent negative impacts such as fishing, decreasing river outflow and climate change. Therefore when considering global issues such as food security, freshwater storage, and ecosystem responses to climate change it is important to be able to identify how ecosystems react to anthropogenic activities and potential indicators of ecosystem robustness.

Overfishing has been shown to change the structure of food webs and cause indirect effects throughout the system e.g. via trophic cascades (e.g. Daskalov, 2002). The presence of food chains, a type of community module, in the system can cause these trophic cascades (Figure 1, Holt 1997). Defining ecosystem robustness as the resistance to change of system biomass, mean biotic group biomass or fishing required for group extinction, I aim to answer the following:

1. How robust are marine and estuarine ecosystems to overfishing?
2. Do community modules indicate the robustness of ecosystems to overfishing?

Mass-balanced trophic networks representing carbon flows of fifteen marine and estuarine ecosystems in South Africa were used. For each biotic group biomasses, imports, exports, respiration and flows to other groups (predation, egestion) were available in terms of mgC m$^{-2}$ day$^{-1}$. Each group was gradually overfished by increasing catch and recalculating group biomasses using a static mass-balance model until the biomass of the fished group was 1% of the initial biomass. Robustness indicators were calculated and community modules were identified and characterized for each catch level.

Robustness of each ecosystem was evaluated by comparing robustness indicators across ecosystems and groups fished. Correlations were determined between robustness indicators and community module measures to assess the role of community modules in ecosystem robustness. In addition, the relationship between robustness indicators and the role a group plays within a module (predator, prey or resource) were compared between catch levels.

References
Ecosystem vulnerability to species loss
Victoria Veshchinskaya
Lomonosov Moscow State University, Moscow, Russia
Email: v.veshchinskaya@gmail.com

Abstract Loss of species has always occurred as a natural phenomenon, but the pace of extinction has recently accelerated dramatically as a result of human activity. Ecosystems are being fragmented, polluted, and impacted by exploitation, and innumerable species are in decline as a result. The degradation or disappearance of a species causes changes that propagate throughout the ecosystem of which it is part. An important challenge in ecology is to elucidate consequences of species loss for the composition and functioning of ecosystems.

Several authors have investigated how structural and functional aspects of ecosystems correlate with ecosystem stability. MacArthur (1955) argued that complexity should enhance the stability of ecosystems. May (1972), however, suggested the exact opposite: he showed that randomly assembled ecosystems become less robust as their complexity increases. Since then, a number of studies have brought forth theoretical arguments and experimental evidence supporting both of these positions (Lehman and Tilman 2000; Ives and Carpenter 2007), in what is known as the “complexity-stability” debate.

The relationship between structure and stability has been explored for both empirically measured and artificially generated ecosystems. Such studies have assessed both local stability in the tradition of May (1972) and stability criteria that are based on responses to large perturbations. Surprisingly, however, few studies built on empirically measured ecosystems have considered the latter, more sophisticated, stability criteria (Worm et al. 2006). The reasons for this lacuna in the literature are not known, but the difficulty of constructing a proper dynamic model on top of empirically measured ecosystem data might be a root cause.

The aim of this study is to fill this long-standing lacuna through an explicit and thorough consideration of dynamic stability in empirically measured aquatic ecosystems. The principal objective is to investigate ecosystem stability under compartment collapses, elucidating how ecosystem topology influences stability. We develop and analyze a dynamic ecosystem network model, apply it to a set of real ecosystems, to predict the cascading changes that can follow the extinction of a species. The impacts of such primary species losses are measured in terms of secondary species extinctions and biomass changes. Fundamental descriptors of ecosystem structure are assessed for their capacity to predict indicators of ecosystem vulnerability to species loss. We calculate correlations between measures of ecosystem structure and indicators of ecosystem vulnerability. The associations found through this analysis reveal which structural features are important for ecosystem vulnerability to species loss.

References
Shocks and the Evolution of Coping Mechanisms in Low-Income Regions

Ali Asjad Naqvi
YSSP 2012, Risk, Policy, Vulnerability, IIASA
Email: asjadnaqvi@gmail.com

Introduction: Both disaster-like negative income shocks and a creeping erosion of income have severe effects on the population in low-income regions (Cavallo & Noy 2010). This paper models the dynamics of the coping mechanisms that individuals employ to mitigate these effects using a multi-agent modeling framework.

Methodology: Based on Naqvi & Rehm (2012), this paper develops an agent-based model (ABM) that captures the adjustment processes taking place in an economy subject to a negative production shock. Heterogeneous agents engage in consumption and production, and interact on labor and goods markets in a monetary circular flow economy.

ABMs excel at incorporating micro foundations and feedback effects, and they are extraordinarily well suited for the study of processes and distributive outcomes.

This paper incorporates insurance and coping strategies of agents into the model that have been identified in the literature (Alderman & Paxson 1992). These include (in an increasing order of escalation) holding buffer stocks and precautionary saving, taking up loans against productive assets, and distress migration.

The model is solved computationally and yields probabilistic estimates for income, wealth, and consumption distribution and poverty, goods prices, and trade and migration flows. The model is calibrated using a unique data set from a low-income region in India (Uttar Pradesh) containing detailed information on the distribution of income, wealth and land ownership, production processes, negative income shocks and coping through loans.

Results: The model outputs shown below depict two consecutive shocks that each reduce farm output by half. At first a sharp reduction in income reduces it below the minimum consumption level, forcing...
low-income groups to run down their savings. Secondly, as wealth levels decline, agents start, thirdly, to borrow against their productive assets. Finally, they run down their productive assets (shown in the middle figure), resulting in poverty traps.

To conclude, this paper shows that time-varying risk aversion (that is, increasing post-shock) can lead to greater vulnerability. As agents resort to adaptation strategies, investment in productive assets and savings is reduced, which translates in low wealth growth. The interaction of agents’ adaptive behavior with environmental factors thus can result in poverty traps for some population groups.

References:
GIS based model for ecological and economical accessibility assessment of forest resources
Alexander Laletin
V.N.Sukachev Institute of Forest SB RAS, Krasnoyarsk, Russia
Email: laletin@iiasa.ac.at

Introduction. Low domestic demand on wood resources and low profitability of forest sector in Russia indicate about failure of the current model of forest management (Sokolov et al., 2009). Evaluation of ecological and economic accessibility is a background for setting the relevant industrial developing parameters and rational use of timber resources as well as well-grounded determination of size and distribution of logging areas. This will promote operation of forest enterprises on the basis of inexhaustible and sustainable forest use (Sokolov et al., 2011).

Ecological and economical accessibility of forest resources – is such a qualitative and quantitative state of a resource, taking into account its location regarding the place of its consumption, considering the existing and projected roads, which is being developed under the state-of-the-art technological level and provides the minimal required level of profitability.

Methodology. GIS data was obtained for a study area – Eniseyskoe forest district (44,000 km²), Krasnoyarsk region, Central Siberia. Used information included: growing stock volume, dominant species, age, site index, land cover, soils, distribution of rivers and roads, distance to nearest existing roads, distance to main consumption points. All information was transferred to a specially developed accounting system in Microsoft Excel. Further (1) all ecologically inaccessible areas were excluded as well as immature forest areas; (2) revenue and total cost of harvesting were calculated, and (3) profitability for the whole territory and any its part was defined.

Results. A model, which estimates the accessibility of forest resources for conditions of Central Siberia, was developed. A map of accessibility is obtained (Fig. 1). Optimal density and total length of forest roads were calculated.

Table 1. Comparison of current indicators with ecologically and economically accessible

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Current</th>
<th>E&amp;E accessible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploitable stock, th. m³</td>
<td>317,514</td>
<td>150,629</td>
</tr>
<tr>
<td>Annual allowable cut, th. m³</td>
<td>4,647</td>
<td>1,524</td>
</tr>
<tr>
<td>coniferous</td>
<td>1,932</td>
<td>986</td>
</tr>
<tr>
<td>deciduous</td>
<td>2,714</td>
<td>537</td>
</tr>
</tbody>
</table>

Optimal density of roads: 2.8 m/ha;
Total length of roads: 12 000 km.

Figure 1. Ecologically and economically accessible forests of Eniseyskoe forest district under current conditions (green color)

References
Sokolov V.A. et al., 2009. Organization of Sustainable Forest use in Krasnoyarsk region, Institute of Forest SB RAS, 361 pp.
Sokolov V.A. et al., 2011. Management of Sustainable Forestry in Krasnoyarsk region: social, economic and environmental aspects of the forest use. Institute of Forest SB RAS, 100 pp.
Projecting deforestation globally using satellite observations, FAO statistics and socio-economic parameters

Xiao-Peng Song
University of Maryland, College Park
Email: xpsong@umd.edu

Tropical deforestation is estimated to account for 12-20% of global greenhouse gas emissions in the 1990s and early 2000s (Houghton 2005). However, developing countries, where most tropical forests are located, often lack the economic and policy incentives to avoid deforestation. The United Nations Framework Convention on Climate Change has recently launched a financial mechanism to reduce emissions from deforestation and forest degradation and enhance forest carbon stocks (REDD+) in developing countries. Policy responses would be uninformed without a firm scientific base. Current research on deforestation needs to be advanced imperatively on at least two significant aspects: (1) to establish deforestation baseline through accurate quantification of historical carbon emissions from deforestation, and (2) to make future projections based on a comprehensive understanding of the mechanisms as well as drivers of deforestation.

Estimations of current forest carbon stocks as well as historical deforestation-triggered carbon emissions suffer from substantial uncertainties. Two recent studies calculated annual carbon emissions from tropical deforestation but presented controversial results. Baccini et al. (2012) suggested a 2.2 PgC/yr for the time period of 2000-2007, while Harris et al. (2012) argued for an annual emission of 0.87 PgC/yr for 2000-2005. In this study, my calculation based on a MODIS (Moderate resolution spectroradiometer) gross forest cover loss product from 2005 to 2010 (Matthew Hansen, personal communication) and a Lidar-based (light detection and ranging) forest canopy height map in 2005 (Simard et al., 2011) reached an annual emission of 0.38 Pg C/yr for the time period of 2005-2010. This result is about 40% of the latest Harris et al. (2012) study and about 20% of the Baccini et al. (2012) study.

Policies addressing future averted deforestation can be advised only if the drivers and mechanisms of deforestation are understood and the deforestation process can be modeled reliably. Numerous studies have demonstrated the complexity of deforestation drivers at local to global scales. In this study remote sensing based deforestation observations from 2005-2010 are modeled as a function of a series of biophysical as well as socio-economic parameters, including the initial forest cover in 2005, initial forest carbon density in 2005, population change from 2005 to 2010, the accessibility of land parcels, etc. The spatial modeling is done for the globe as well as for the three tropical continents. 25-50% variance of deforestation can be explained by the selected explanatory variables, depending on the continent. It is also demonstrated that deforestation at current location in current period is strongly affected by the presence of neighborhood deforestation in previous period.

References
Reducing emissions from deforestation: explaining stakeholders’ perceptions on REDD+ policy

Pheakkdey Nguon

Since its inception in the 2007 annual meeting of the United Nations Framework Convention on Climate Change, policies aiming at decreasing the rate of tropical deforestation that are tied to reducing the impacts of global climate change – hereinafter referred to as REDD+ – has been one of the highly contested topics in both academic debates and policy negotiations. As a concept, REDD+ represents a form of environmental governance that transcends multiple structures of decision-making and organizations, assembles actors with diverse interests, and translates into numerous implementation procedures. Given this complexity and multiplicity of interpretations, this research paper asks what explains stakeholders’ perceptions on REDD+ policy. Drawing on some of the prominent theories from the various disciplines in social sciences, this paper theorizes that stakeholders’ perceptions on REDD+ are influenced by the institutions, ideologies, interests and knowledge that they bring into the policy process. These factors are further hypothesized to be responsible for the different levels of saliency, credibility and legitimacy that those stakeholders associate with the claims on the effectiveness, efficiency, equity, and co-benefits (3Es) of the proposed policy, which then leads to their acceptance of, resistance to or indifference toward REDD+. There are two sections in this paper. The first is to construct a conceptual framework that integrates these different theories, concepts and variables followed by a description on the operationalization of the framework. Figure 1 illustrates the conceptual framework. The second section focuses on the design of research methodologies necessary for an empirical application of the proposed framework in a REDD+ participating country. Overall, this paper demonstrates how theories in social sciences can contribute to empirical understanding on how perceptions are formed in regards to one of the most pressing global environmental governance projects that currently involves more than 50 tropical countries. This understanding will contribute to both academic debates and policy negotiations on the significance of REDD+ policy in reducing deforestation and the impacts of climate change.

Figure 1: Conceptual framework explaining stakeholders’ perceptions on REDD+

References
Applying Culture Theory to Reducing Emissions from Deforestation and forest Degradation (REDD+)

Tobias Dan Nielsen
Department of Political Science, Lund University
tobias.nielsen@svet.lu.se

Introduction. A UN led governance mechanism to reduce the rate of deforestation and its impact on climate change (REDD+) has emerged as one of the most anticipated governance mechanism within the climate change regime. REDD+ is perceived to establish incentives for developing countries to protect and better manage their forest resources, by, basically, paying forest owners to not cut down trees. However, REDD+ has proven to be highly problematic for decision makers to agree on. REDD+ negotiations at UNFCCC have been hampered by the complexities of issues on REDD+ and disagreements on core issues. Moreover, mounting skepticism and critique has emerged in the academic literature and amongst especially indigenous groups and NGOs pointing to a lack of inclusiveness in the policy process.

Theory. Cultural Theory (CT) argues that there are four general ways of organizing, justifying, and perceiving social relations (world views), and that efforts to resolve complex problems, such as REDD+, that are not based on all four world views threatens the effectiveness and robustness of the policy outcomes. Instead successful efforts to resolve the complex issues of REDD+ need to be a creative, flexible mixes of these four ways worldviews. This paper will test the relevance of this core CT hypothesis in the case of REDD+ and investigate how CT can provide guidance for future policy-making on REDD+.

Methodology. The main method is discourse analysis, which is used to identify the story-lines of each of the CT world views. Hence, each worldview has specific arguments, rhetoric, assumptions, and perceptions of how to deal with deforestation. What I do is look for these story-lines in the policy debates on REDD+ and assess the accessibility and responsiveness that each voice has in the debates. A second part of the analysis examines case studies on forest polices identifying how the inclusion or lack of inclusion of the different worldviews impacts forest policies. The aim is to examine the insights that CT can bring into the REDD+ debate from these case studies to avoid the potential failure of basing its policy largely on a single worldview.

Results. The results of the fist analysis demonstrates that although the policy process of REDD+ may be perceived as having a high degree of plurality in terms of including the active world views, this study demonstrates that REDD+, as an idea and the way it is being implemented, is dominated by one world view (hierarchy).

Conclusions. The dominance of hierarchical world view in understanding, justifying, and shaping REDD+ polices has clear impacts on the REDD+ governance mechanism. The affect of this is that REDD+ is leaving out valuable knowledge and perspectives on shaping its policies and is consequently heading for failure. However, the study also provides insights into how this fate may be adverted by facilitating a more inclusive policy debate that fully embraces the views of all four worldviews.

References
**Exploration of Historic and Projected Water Use in the United States**

Understanding past trends and drivers to better forecast water use

Debra Perrone  
Vanderbilt Institute for Energy and Environment, Vanderbilt University  
*Email: debra.perrone@vanderbilt.edu*

**Introduction.** Increased population and patterns of population density, economic growth, and development all increase water, energy, and food demands. The impacts of a changing climate will exacerbate competition for these resources, especially given the strong interrelationships among water, energy, and food. Although demand for individual resources has been studied, a systematic evaluation of readily available data has not been undertaken to evaluate water-energy-food linkages. The original objective of my YSSP was to create water demand scenarios for the United States under different climate projections, but obstacles associated with acquiring and aligning a comprehensive time series of water use data provided an opportunity to expand my research.

**Research Questions:** What water use sectors can be used in the time series for a consistent comparison? What are the tradeoffs associated with the data? To what level are these tradeoffs and limitations acceptable for forecasting?

**Methodology.** Existing data from the United States Geological Survey (USGS) (MacKichan and Kammerer 1961; Murray 1968; Murray and Reeves 1972; Murray and Reeves 1977; Solley, Chase et al. 1983; Solley, Merk et al. 1988; Solley, Pierce et al. 1998; Hutson, Barber et al. 2004; Kenny, Barber et al. 2009) was reviewed, aligned, and analyzed so that a comprehensive database could be created. Tradeoffs and limitations associated with the data were identified and confirmed during personal communication with an author of the USGS water use reports. These tradeoffs and limitations were then complimented by a comprehensive literature review of past water use estimates and projections.

**Results.** This work presents a water use database for multiple demand-side sectors in the United States and a comprehensive literature review of past water use estimates and projections for the United States.

**References**

Estimates of forest fire NOx emissions in Russia between 1998 and 2010

Schreier Stefan
University of Bremen / Institute of Environmental Physics
Email: schreier@iup.physik.uni-bremen.de

Introduction
Nitrogen oxides (NO and NO2) are reactive gases, affecting atmospheric chemistry, air pollution, and climate. Boreal forests cover more than 30% of total global forested areas and store large amounts of nitrogen (N) which is an essential nutrient for all living organisms. Wildfires across these ecosystems release large masses of N, mainly in form of NOx. However, estimating the exact amount of fire NOx emissions still remains complicated as indicated by large uncertainties between different emission inventories.

Material and methods
In this study, bottom-up estimates of NOx from forest fires in Russia between 1998 and 2010 are compared with satellite-based NO2 concentrations. The amount of NOx emitted from forest fires was determined for each pixel (0.25° x 0.25°) using a modified equation initially introduced by Seiler and Crutzen (1980). The parameters required for using this equation are derived from the Integrated Land Information System of Russia (ILIS) developed by IIASA (Shvidenko et al., 2011). The satellite-based spectral retrieval of tropospheric vertical columns (VC) NO2 is achieved by applying the Differential Optical Absorption Spectroscopy (DOAS), based on Beer-Lambert’s law (Richter et al., 2005). In order to separate pixels influenced by anthropogenic emissions, the population density from the Global Rural-Urban Mapping Project (GRUMPv1) was implemented in the algorithm. The comparison between bottom-up NOx and satellite-based VC NO2 was then performed for the unpopulated part of Russia.

Results
In general, bottom-up NOx and satellite-based VC NO2 show high correlation when compared with burned forest area. According to higher amounts of fuel available in the summer season, the slope is higher, meaning that more NOx is released per unit burned area. Further, the relationship between bottom-up NOx and satellite-observed VC NO2 based on monthly and yearly sums shows high coefficients of determination with R² = 0.85 and R² = 0.81, respectively. In this study, the total amount of NOx emitted from forest fires in Russia between 1998 and 2010 is estimated at 7.3 x 10⁶ t (5.6 x 10⁵ t yr⁻¹).

Conclusions
When compared to global inventories of biomass burning NOx emissions (e.g. Kaiser et al, 2012), Russian forest fires account for about 6% of all NOx released on average per year from vegetation fires globally. However, according to future climate change scenarios, the contribution of Russian forest fires may even increase in the near future.

References


What mechanisms explain soil carbon dioxide flux under fluctuating rainfall patterns?

Sarah Evans
Colorado State University
evanssar@gmail.com

**Introduction:** Much of the earth’s terrestrial carbon is stored in soil. Large rainfall events result in a flux of carbon dioxide from soil that is larger than expected based on current relationships between soil moisture and respiration, and underestimated by current ecosystem models. We hypothesized that under fluctuations in moisture conditions, additional physical and biological mechanisms - that current predictive models do not explicitly consider - could help explain the discrepancy between predictions of CO2 flux and field observations.

**Methodology:** We investigated the mechanism of this carbon flux after a large drought and rainfall event using an individual-based model developed at IIASA. Because this model is spatially explicit and includes microorganisms, we were able to test the relative effect of 4 mechanisms hypothesized to contribute to the magnitude and timing of this increase in carbon dioxide flux with fluctuating moisture: water-dependent growth of microorganisms, diffusion of substrates, heterogeneity in soil structure, and microbial community diversity.

**Results:** We found that diffusion and water-dependent growth had the largest relative effect on the magnitude of the carbon dioxide pulse, especially in combination, and this effect was mediated through the accumulation (and subsequent diffusion) of dissolved organic carbon under drought. In addition, the diversity of the microbial community and diffusion of substrates (access) affected how quickly the CO2 pulse occurred after a rainfall event.

**Conclusions:** Overall, this suggests that both spatial structure and biological dynamics, which are currently excluded from large ecosystem models, may be important for predicting dynamics under these highly fluctuating moisture patterns, which are expected to become more frequent under future climate regimes.
Better inclusion of land management in global ecosystem service models

Katalin Petz
Environmental Systems Analysis Group, Wageningen University, PO Box 47, 6700, AA, Wageningen, The Netherlands
Email: katalin.petz@wur.nl, katalin.petz@gmail.com

Land use change and intensification are main drivers of ecosystem (service) degradation (Foley, DeFries et al. 2005). However, in current global ecosystem service (ESS) models land management is often restricted to land cover (Letourneau, Verburg et al. 2012). Even if considered, management characteristics, such as grazing intensity and forest management are represented very coarsely (Verburg, van Asselen et al. 2012). Therefore, this study focuses on the better representation of land management in these models. First, we provide an inventory of global data and propose four management states to be used for modelling. We argue that such a characterization is necessary to synthetize information on land management and make a bridge over scales. As a next step, we show how global ESS modeling can benefit from more detailed and higher resolution information on land management. We demonstrate the ESS trade-offs to which changing land management lead in African forests and rangelands. In the first case, we established literature-based modelling relationships to estimate forage consumed and carbon sequestered by vegetation as a function of grazing intensity using data on current stocking rates. In the second case, we used the Global Forest Model (Kindermann, Obersteiner et al. 2006) to illustrate how potential wood harvest and biomass carbon change with forest rotation time. Results show that wood harvest is the highest under very intensive; whereas biomass carbon under no or extensive management. Balance between different services can be achieved through extensive management, which maximizes carbon stored in biomass while wood harvest is still possible. Based on our findings the potential improvement of the global IMAGE model (MNP 2006) is discussed. Among other aspects we suggest the inclusion of the more accurate information on grazing intensities and its effect on biomass stock and the linkages between wood harvest and biomass carbon. We conclude that the proposed management states, the global data inventory and the two application examples are beneficial for the further inclusion of land management into global ESS modeling.

Assessing and Improving the Validation Dataset of Land Cover Mapping

Yuanyuan ZHAO  
Center for Earth System Science, Tsinghua University, Beijing, China  
Email: yy-zhao10@mails.tsinghua.edu.cn

Introduction. Land cover mapping is the most direct way in portraying and understanding the dynamic changes of earth physical surface, and consequently is key to global change and Earth system studies. With the efforts of remote sensing community, several global land cover maps are finished and freely available at various spatial resolutions. However, considerably high disagreements were found among those products in many parts of the world, especially in ecological transition zones where landscapes are highly heterogeneous. This calls for finer land cover mapping and further validation, which would be greatly facilitated by a global validation dataset, especially a coordinated, well-described, comparable and frequently updated one. Since collecting the validation dataset is the most time- and labor-consuming part, volunteered geographic information (VGI) will be a good source to help construct this validation dataset. Geo-Wiki is an on-line platform for global volunteers to provide relatively accurate and up-to-date land cover information based on Google Earth and their local knowledge. A comprehensive assessment was conducted with the validation datasets from Geo-Wiki.

Methodology and Results. The datasets used for this project are from two competitions: the human impact competition (with one single dominant land cover type) and the disagreement competition (with more than one land cover types and their percentages). Firstly, kernel density was estimated to describe the distribution of the validation records contributed by the volunteers around the world. The validation points for competition of disagreement were more likely distributed in mountains and transition zones. Secondly, spatial variance of the consistency among volunteers was estimated and mapped, to show how easy or difficult it is for the volunteers to describe the land cover type and coverage of a pixel at a given location, by the measure of standard deviation and Euclidean distance. The spatial variance map shows that the most inconsistent recognition appears mainly in the eco-regions of tropical forest, taiga, tundra, grasslands and shrublands. Thirdly, a confusion matrix was built to explore the major confusion pairs of land cover types among the volunteers, and the confusion matrices for different biome were calculated as well. Fourthly, to assess the quality of the validation points, logistic regression was conducted to explore the relationship between the occurrence of the dominant choice of the volunteers matched with the experts and the percentage of volunteers agreed on the dominant choice, as well as the average their confidence. If more than 37.5% of volunteers agreed on the dominant answer at the mean confidence level, then the probability of the occurrence will be greater than 0.8, for the area where the high resolution images are available on Google Earth.

Conclusions. For the eco-regions, with higher inconsistent recognition among volunteers, such as taiga, tundra, and shrublands, more background knowledge and tutorial need to be provided to the volunteers to get a better crow-sourcing dataset. The reliability of the dominant choice of the volunteers increases with the percentage of volunteers agreed on the dominant answer and their confidence. The users of this crow-sourcing dataset could filter the data, according to the predicted reliability estimated by the logistic regression model.

Author Index

Alexander Laletin “Ecological and economical accessibility assessment of forest resources” 33
Angan Sengupta “Educational Change and its Impact on Fertility and Demographic Dividend of Future India” 13
Anubhab Pattanayak “Poverty, Risk, and Climate Change in Rural India: Characterizing Sensitivity of Farming Communities to a Changing Climate” 11
Christoph Bertram “Energy Demand Scenarios for the Transport Sector” 24
Danielle Nel “Public Private Partnerships in South African renewable energy sector: an integrated assessment” 14
Debra Perrone “Exploration of Historical Water Demand Trends in the US” 37
Fangyi Li “How can China meet its energy intensity target” 20
Firdos Khan “Assessment of Water Flow in the Indus River and Management of Water at Tarbela Dam Under Different Climate Change Scenarios” 26
Harald Ficker “A Management Model for Alpine Fish Populations under Temperature Stress” 28
Hem Dholakia “Assessment of future air quality and health impacts in Delhi and Mumbai” 12
Hiroto Shiraki “Enhancements of AIM energy system model aimed at providing robust solutions for mitigation of future climate change” 22
Jung Hun Lee “Curbing Corruption in Public Good Games” 16
Karol Opara, Pin Pin Oh “Modelling biodiesel reactor” 25
Katalin Petz “Inclusion of land management in global ecosystem services modeling: examples for management-caused tradeoffs in rangeland and forest ecosystems” 40
Kei Kabaya “Impact assessment of energy efficiency improvements in the residential sector in Japan” 19
Ki-Chul Choi “Development of Source-Receptor Relationships over South Korea in support of GAINS model” 18
Kyeongah Nah “The evolution of malaria incubation time” 9
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morag Ayers “Ecosystem robustness to overfishing: do community modules play a role”</td>
<td>29</td>
</tr>
<tr>
<td>Olha Danylo “Spatial inventory of greenhouse gas emissions in the residential sector”</td>
<td>23</td>
</tr>
<tr>
<td>Pheakkdey Nguon “Reducing emissions from deforestation: explaining stakeholders' perceptions on REDD+ policy”</td>
<td>35</td>
</tr>
<tr>
<td>Pin Pin Oh, Karol Opara “Modelling biodiesel reactor”</td>
<td>25</td>
</tr>
<tr>
<td>Sam Hyun Yoo “Educational differentials in completed fertility in Korea”</td>
<td>17</td>
</tr>
<tr>
<td>Sarah Evans “What mechanisms explain soil carbon dioxide flux under fluctuating rainfall patterns”</td>
<td>39</td>
</tr>
<tr>
<td>Sebastian Busch “Towards a framework for sharing the benefits of deploying renewable energies across borders: possible contributions from cooperative game theory”</td>
<td>15</td>
</tr>
<tr>
<td>Stefan Schreier “Estimates of forest fire NOx emissions in Russia between 1998 and 2010”</td>
<td>38</td>
</tr>
<tr>
<td>Taiki Fuji “Effects of climate-induced changes in river flows on Japanese seabass”</td>
<td>27</td>
</tr>
<tr>
<td>Tobias Nielsen “Applying Cultural Theory to the Emerging Policy Scheme on Reducing Emission from Deforestation and forest Degradation (REDD+)”</td>
<td>36</td>
</tr>
<tr>
<td>Victoria Veshchinskaya “Ecosystem vulnerability to species loss”</td>
<td>30</td>
</tr>
<tr>
<td>Vijay Limaye “Refined Dose-Response Functions for Small Particulates: A Health Impact Analysis in GAINS-Asia”</td>
<td>8</td>
</tr>
<tr>
<td>Xiaopeng Song “Comparing Methods for Identifying Optimal Forest Management”</td>
<td>34</td>
</tr>
<tr>
<td>Yadong Yu “Construction of an Optimal Model for Resource Productivity in China”</td>
<td>21</td>
</tr>
<tr>
<td>Yuanyuan Zhao “Assessing and improving the validation datasets for land cover mapping”</td>
<td>41</td>
</tr>
</tbody>
</table>