

SEI U.S. CENTER

ANNUAL REPORT

2010



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INTRODUCTION

The Stockholm Environment Institute (SEI) is an international not-for-profit research organization that has been engaged in environment and development issues at the local, national, regional and global policy levels for more than 20 years. Our goal is to bring about change for sustainable development by bridging science and policy, conducting integrated analysis that supports decision-makers.

SEI's work is interdisciplinary in nature, drawing upon engineering, economics, ecology, ethics, operations research, international relations and software design. SEI is based in Stockholm, Sweden, and has additional research centers in the U.K., Estonia, Thailand, Tanzania, and the United States.

SEI's U.S. Center is an independent research affiliate of Tufts University in Somerville, Massachusetts, and also has offices in Davis, California, and Seattle, Washington. The Davis office is affiliated with the University of California-Davis, and the Seattle office, with the University of Washington.

Our work is currently arranged in seven areas:

- Water Resources**
- Energy Modeling**
- Climate Economics**
- Climate Mitigation Policy**
- Emissions Trading & Offsets**
- Climate Equity**
- Sustainable Futures**

In addition to providing policy-relevant analysis, our programs build capacity for integrated planning and action throughout the world. Our decision support tools are used by thousands of researchers and policymakers in more than 170 countries.

CENTER DEVELOPMENTS

This was the fourth full year of SEI-US operation since the Center's transition in 2006 to Tufts University. The management structures put in place in 2006 have continued to operate well. In 2010, with direction from its board, SEI-US undertook a planning exercise to formulate a strategy for how the Center will evolve over the next three to five years. The Center's Strategic Plan is currently being finalized, after being presented at the November 2010 U.S. Center Board meeting.

Staffing levels remained relatively unchanged compared to 2009, with an average of 23.9 full-time equivalent (FTE) staff as of September 30, compared to 23.3 FTEs in 2009.

2010 HIGHLIGHTS

SYMPOSIUM

In November, we organized and hosted a research symposium, **“Cross Currents: Water and Energy Challenges in the 21st Century,”** held on November 4 at Tufts University. About 80 people attended the event, which included 10 speakers and two panel discussions.



The symposium focused on the growing interconnections between water and energy policy. One emerging challenge is the provision of adequate water supplies to match the world’s growing demands for energy. This challenge is likely to be difficult both with traditional approaches to energy production such as thermal power plants, which require huge amounts of cooling water, but also for some renewable energy systems such as solar power, which need to be sited in areas where sunshine is plentiful but water generally is not. A second major challenge is the fast-growing energy needs of our water supply systems. These energy needs will continue to grow as we become more dependent on groundwater from steadily falling aquifers. A third emerging challenge is how best to manage the competing demands on our water systems, particularly with respect to how dams are managed for hydropower, agricultural irrigation and the protection of ecological systems. All these challenges are emerging at a time when there are increasing concerns over how climate change will affect the future reliability of freshwater supplies.

Our symposium explored how these and other perspectives on water and energy might be assembled into a useful framework that can support the development of sustainable water and energy management policies in a changing world. Speakers included SEI staff as well as leading academics, policy advocates and representatives of the science-based NGO community. Highlights of the day included a presentation by Marisa Escobar of SEI about her innovative modeling and research, which is helping to highlight the dire future for Chinook salmon in California – impacted by hydropower development and worsening climate change – and the various policy options available to avoid their oncoming extinction. In addition, Jack Sieber and Charlie Heaps outlined SEI’s recent efforts to integrate the LEAP and WEAP models to create a powerful tool for examining energy-water policy issues.

AWARDS

At the World Environmental & Water Resources Congress, held May 16-20 in Providence, Rhode Island, David Purkey, Jack Sieber, Chuck Young and Brian Joyce (and co-authors) received the Quentin Martin Best Practice Paper Award for this paper, published in 2009:

David Yates, David Purkey, Jack Sieber, Annette Huber-Lee, Hector Galbraith, Jordan West, Susan Herrod-Julius, Chuck Young, Brian Joyce, and Mohammad Rayej (2009). “Climate Driven Water Resources Model of the Sacramento Basin, California.” *Journal of Water Resources Planning and Management* 135:5, 303-313.

RESEARCH AREAS IN 2010

WATER RESOURCES

Our Water Resources program develops and promotes integrated approaches to freshwater assessment and policy, through the development and application of SEI's Water Evaluation and Planning system (WEAP) and capacity-building to help others apply WEAP. Our research advances integrated approaches to freshwater assessment and policy. We work throughout the United States, Central and South America and the Caribbean, the Middle East, Africa and Asia. For more information on WEAP, please visit www.weap21.org.

Simulating the Effects of Climate Change on California Central Valley Project Water Demand

The effects of climate change on California's agricultural crop water demand in the coming century are not yet well understood. In this project we use a simulation model to study the various effects of climate change on crop water demand. The physical processes simulated include: the reduction in vapor loss due to stomatal closure, the effects of CO₂ fertilization on canopy development, changes in growing season timing and length, and the effects of increased temperature on crop water demand.

Client: U.S. Bureau of Reclamation

Partners: National Center for Atmospheric Research (NCAR), CH2M Hill

Timeframe: 2009 - ongoing

Budget: \$300,000

Staff: Young, C.; Flores, F.

Improving Water Productivity and Reducing Water-Related Conflict in the Andes

We implemented a dynamic link between SEI's WEAP system and the FIESTA model developed by AguaAndes to provide information on water availability, demands, and management systems. The project was implemented in five watersheds in collaboration with local stakeholders actively participating in water resources negotiations.

Client: Climate Program on Water and Food (CPWF) – Consultative Group on International Agricultural Research (CGIAR)

Partners: Universidad Nacional de Colombia Sede Palmira, WWF-Colombia, King's College-London.

Timeframe: 2010-13

Budget: \$238,896

Staff: Purkey, D.; Escobar, M.

Developing Climate Risk Management Strategies for Water Utilities

Climate change adds a layer of complexity to the already substantial challenges facing water utility managers. As future conditions become increasingly uncertain, decision processes responding to these changes are necessarily evolving away from a deterministic prediction-based paradigm to one based on vulnerability identification and adaptation planning. SEI is developing a risk assessment and management framework for water utilities to help them learn about potential climate impacts and how these affect decision-making and planning. The framework will be piloted for the New York City water supply system and with the Colorado Springs Utilities in 2011.

Client: Water Research Foundation

Partners: RAND Corporation, Hazen and Sawyer

Timeframe: 2010-12

Budget: \$450,000

Staff: Purkey, D.; Fencl, A.

Exploring the Water-Energy Nexus in the American River Watershed, California

Water and energy policy are increasingly connected and face interrelated challenges: 1) providing adequate water supplies for growing energy demands; 2) meeting the fast-growing energy needs of our water supply systems, and 3) managing the competing demands on our water systems. These challenges are emerging at a time when there are increasing concerns over how climate change will affect the future reliability of freshwater supplies and how current energy policy influences climate change. This project linked SEI's water and energy planning models, WEAP and LEAP, to provide new insights into the cross-cutting challenges of integrated water and energy planning. The combined model was applied to a case study in the American River Watershed in California.

Client: California Energy Commission

Partners: Lawrence Berkeley National Laboratory

Timeframe: 2010

Budget: \$50,000

Staff: Heaps, C.; Sieber, J.; Purkey, D.

Statewide Integrated Water and Energy Planning in California

This project continues to link SEI's water and energy planning models, WEAP and LEAP, which together offer a unique integrated platform to explore water and energy interactions and feedbacks. There is arguably no better place to explore this dynamic than in California, where it is estimated that nearly 20% of all energy use is associated with moving, lifting, treating, and using water. SEI partnered with three key organizations in California for this project: the state Department of Water Resources, which is responsible for guiding California's water future; the California Energy Commission (CEC), the coordinating agency to address climate change with the responsibility of achieving reductions in greenhouse emissions; and the Pacific Gas and Electric Company (PG&E), which provides natural gas and electric service to millions in northern and central California. We will link water management options, such as reuse, reservoir re-operation, demand-side management, land use changes, etc., as represented in the WEAP portion of the tool, to models of the electric utility serving the water utilities, as represented in LEAP. In addition to a new decision support tool, the results of this case study will be used to develop a final report, *Northern California's Water Future and its Implications for Energy Demands*, to inform both the State's Water Plan, and the missions of the CEC and PG&E.

Client: National Oceanic and Atmospheric Administration (NOAA), California Energy Commission (CEC)

Partners: National Center for Atmospheric Research (NCAR), Pacific Gas and Electric Company (PG&E), Lawrence Berkeley National Laboratory

Timeframe: 2010 - ongoing

Budget: \$260,000 (NOAA), \$50,000 (CEC)

Staff: Purkey, D.; Joyce, B.; Sieber, J.; Heaps, C.

Supporting Integrated Resource Planning in the Mid-Pacific Region of the U.S. Bureau of Reclamation

In 2010, SEI worked with the Bureau of Reclamation to develop an Integrated Resource Plan for the Central Valley Project in California. The Central Valley Project Integrated Resource Plan (CVP IRP) is intended to evaluate current and future water balances and assess the degree to which these balances will be influenced by future changes in climate, socioeconomic, and environmental conditions. In addition to these evaluations, the CVP IRP assesses the impacts of these factors on infrastructure and operations, develop adaptation strategies, and perform trade-off analyses to determine the effectiveness, efficiency, and acceptability of potential responses to socioeconomic climate-induced supply and demand imbalances.

Client: U.S. Bureau of Reclamation

Partners: CH2M Hill

Timeframe: 2010

Budget: \$119,000

Staff: Joyce, B.; Purkey, D.; Fencil, A.

Integrating Economic Optimization Considerations into California Water Planning

SEI, in collaboration with University of California–Davis, is developing a link between the WEAP application of the Sacramento Basin, San Joaquin Valley and the Tulare Lake hydrology and SWAP, the State Wide Agricultural Production model for the Central Valley. The study dynamically simulates the relationships between water supply and land use management decisions under a number of climate change scenarios.

Client: U.S. Bureau of Reclamation

Partners: University of California–Davis

Timeframe: 2010 - ongoing

Budget: \$138,000

Staff: Purkey, D.; Forni, L.

Water Management Implications of Glacier Evolution in the Himalaya

Himalayan glaciers are retreating rapidly. Using a Ganges basin scale WEAP model, the project analyzed the climate, energy and water balances in two glaciated sub-basins in the Nepal Himalaya – Dudh Kosi and Tama Kosi – near Mount Everest (Qomolangma). Using multiple tools – distributed radiant energy balances in GRASS GIS, extraction of 16-day interval MODIS satellite-derived albedo, and model sensitivity analysis – we were able to provide bounds on glacial melt and area loss. Within limits of model uncertainty, our findings indicate 5-11% loss of glacial area and 37-51% contribution of glacial melt to runoff on these basins over a 22-year period starting in 1980. Further, glacier albedo evolution is a key driver of energy, water and glacial mass balances.

Client: SEI IPS 2010 Bridge Funds

Timeframe: 2010

Budget: \$38,000

Staff: Mehta, V.; Escobar, M.; de Condappa, D.

Innovation and Diffusion of Sustainable Agricultural Water Resource Management in a Changing Climate: Case Study in Northeast Thailand

SEI researched how innovative agricultural water resources management techniques for climate adaptation in Northeast Thailand are disseminated. Social network analysis was utilized to compare a village that had worked with an Oxfam climate adaptation project and a village that had not engaged in an external adaptation project.



Client: Swedish International Development cooperation Agency (SIDA), NOVA project

Partner: Earth Net Foundation

Timeframe: 2010

Budget: \$55,500

Staff: Mikhail, M.; Fencel, A.; Kemp-Benedict, E.; Naruchaikusol, S.

Managing Groundwater in the Middle East and North Africa

In order to help promote integrated water resources planning in the MENA region, SEI has enhanced WEAP to connect it to the MODPATH groundwater particle tracking model. The work was done in partnership with the Arab Centre for the Study of Arid Zones and Dry Lands (ACSAD, based in Damascus, Syria) and the German Federal Institute for Geosciences and Natural Resources (BGR). The project also involved the organization of a major WEAP conference in Syria.

Client: German Federal Institute for Geosciences and Natural Resources (BGR)

Partners: The Arab Centre for the Studies of Arid Zones and Dry Lands (ACSAD)

Timeframe: 2006-10

Budget: \$150,000

Staff: Sieber, J.; Purkey, D.

Managing Water Systems to Prevent Expansion of Invasive Species under Climate Change

SEI worked with Colorado State University to develop tools that were used to investigate the management of invasive species in the Upper Green River in Wyoming. SEI has developed a WEAP application for the basin that simulates natural hydrological processes and water management operations. The WEAP model considered the effects of climate and water management on stream flows throughout the river basin. WEAP model outputs were linked to riparian and aquatic habitat models (developed by Colorado State University) that were used to estimate habitat suitability indexes for invasive species.

Client: U.S. Environmental Protection Agency

Partners: Colorado State University

Timeframe: 2009-10

Budget: \$100,000

Staff: Purkey, D.; Joyce, B.; Mikhail, M.

Modeling Riparian Vegetation Establishment along the Sacramento River in California

Operation of water management structures such as dams and diversions often negatively impact vegetation growth which serves as wildlife habitat and a source of food and fuel for human communities. SEI developed a detailed model of riparian vegetation establishment. The model considers soil-plant-water physical processes allowing for an accurate estimation of vegetation survival under various river management scenarios. The model is being applied to help design new infrastructure investments and operating regimes in the Sacramento Valley.

Client: U.S. Bureau of Reclamation

Partners: University of California–Davis, WRIME Inc.

Timeframe: 2007 - ongoing

Budget: \$372,577

Staff: Young, C.

Sharpening Drought Plans to Consider Climate, the Watershed, the Regulatory Environment, and the Forces of Change

SEI collaborated with the El Dorado Irrigation District to investigate the potential impacts of climate change on a water system that depends to a large degree on the accumulation of snow at high elevation during the winter and the progressive melting of this snow during the late spring and early summer. A WEAP application was developed for the system in order to test drought management triggers and actions that were defined by the district. It was assumed that historic hydrologic patterns are representative of future conditions, but climate change calls this assumption into question. This project attempts to help introduce notions of uncertainty and risk management into the definition of drought plan triggers and actions adopted by the district. A particularly exciting innovation is the dynamic integration of an econometric model of water user behavior into the WEAP application.

Client: National Oceanic and Atmospheric Administration (NOAA)

Partners: University of California–Berkeley, National Center for Atmospheric Research

Timeframe: 2007-10

Budget: \$170,000

Staff: Purkey, D.

Preventing Loss of Ecosystem Services Provided in California

Chinook salmon are the pinnacle species in the California’s riverine aquatic ecosystems. Historically these large fish spawned in most of the rivers and streams which flowed into the Pacific north Monterey Bay. Based on hydrologic and climatic conditions, individual streams accommodated genetically different salmon populations, or runs. Spring-run salmon return from the ocean in March and April when the rivers are high and the water is cold. The spring run in California has been reduced to only a few streams, which are at grave risk due to climate change. This project used a WEAP application linked to a model of the salmon life-cycle to investigate what management options can better protect spring-run salmon. The project also investigated the impact on the whole ecosystem should this species become extinct.

Client: U.S. Environmental Protection Agency

Partners: University of California–Davis

Timeframe: 2007-10

Budget: \$376,525

Staff: Purkey, D.; Escobar, M.

Updating the California Water Plan

The California Water Plan provides a framework for water managers, legislators, and the public to consider California’s water future. To support California in this effort, SEI is developing an application of WEAP that will serve as the analytical foundation for the overall process. The application allows various strategies to be assessed within the context of a range of uncertainties relating to future trends in water demand and climate change.

Client: California Department of Water Resources

Partners: RAND Corporation, MHW Inc., National Center for Atmospheric Research

Timeframe: 2008 - ongoing

Budget: \$185,000

Staff: Joyce, B.; Purkey, D.; Mehta, V.; Sieber, J.



Integration of Anticipated Water Demand into Surface Water Allocation Decision-Making

SEI partnered with the U.S. Bureau of Reclamation to develop a spatially based field water balance and irrigation delivery system model for investigation of water allocation in California’s Central Valley Project. The objective is to improve the consideration of short and medium-term water demands into decisions related to the allocation of available surface water supplies. Previously these allocation decisions considered only reservoir storage and anticipated reservoir inflows as parameters in defining water allocation. The tool will be used to evaluate the potential impact of climate change on agriculture in California and the implications of these changes in water allocation rules.

Client: U.S. Bureau of Reclamation

Partners: WRIME Inc., RMA Inc., National Center for Atmospheric Research

Timeframe: 2007-10

Budget: \$526,640

Staff: Young, C.; Joyce, B.

Incorporating Economics into Water Planning in the Middle East

SEI worked with academic partners to link an economic optimization model, MYWAS, developed for a key region of the Middle East to a WEAP application of the same geography. MYWAS stands for "Multi-Year Water Allocation System" and was written in GAMS, the General Algebraic Modeling System. This project included making major modifications to WEAP.

Client: Frank Fisher, Massachusetts Institute of Technology

Timeframe: 2009 - ongoing

Budget: \$64,200

Staff: Purkey, D.; Sieber, J.; Kemp-Benedict, E.; Huber-Lee, A.

Integrating Uncertainty into Water Resources Planning in California

As part of continued collaboration with the El Dorado Irrigation District (EID) initiated under the NOAA project, SEI is working with partners to implement a planning process leading to the development of a legislatively mandated Urban Water Management Plan that takes into consideration the uncertainties facing EID. In addition to considering climate and socio-economic uncertainty, SEI also integrates changing risks of catastrophic wildfire on watershed hydrology into the EID WEAP application.

Client: California Energy Commission

Partners: RAND Corporation, El Dorado Irrigation District

Timeframe: 2009 - ongoing

Budget: \$75,000

Staff: Purkey, D.; Mehta, V.

Climate Change and Urban Water Management around Lake Victoria

SEI developed WEAP models of the urban water utilities in three cities surrounding Lake Victoria. These models have been used to assess the potential impacts of climate change on available water supplies and water demands in these utilities in order to assess impacts to system performance and to define appropriate adaptation measures that will allow these utilities to offer an adequate level of potable water service to their residents.

Client: UN Habitat

Partners: Alliance to Save Energy, Lawrence Berkeley National Labs, Climate XL, ReSolve

Timeframe: 2009-10

Budget: \$52,100

Staff: Purkey, D.; Mehta, V.

Linking Hydrological Models to Ecosystem Databases

Ecological data are often dispersed between numerous databases using different formats. The University of California–Berkeley developed a database standard for such environmental data, called the DataCube. SEI worked with partners at Berkeley to test strategies for linking modeling tools such as WEAP to the DataCube in the context of an application to a critical coastal watershed in California, San Gregorio Creek.

Client: University of California–Berkeley

Partner: Lawrence Berkeley National Labs

Timeframe: 2009-10

Budget: \$57,240

Staff: Purkey, D.; Mehta, V.; Sieber, J.; Bedig, A.

Representing Complex Environmental Regulations in Integrated Water Resources Planning

The Sacramento-San Joaquin Delta in California is an important Pacific Coast estuary in North America and also a central feature of California's water management systems. Competition between ecosystem preservation and water management has placed this estuary in peril, leading to complex environmental regulations to govern

freshwater exports from the Delta. Working with the major urban water utility, SEI has modified WEAP to examine these complex state-based ecosystem regulations for use in planning for the water supply future in Southern California.

Client: Metropolitan Water District of Southern California

Partners: CDM Inc., RAND Corporation

Timeframe: 2009-10

Budget: \$36,328

Staff: Purkey, D.; Joyce, B.; Sieber, J.

ENERGY MODELING

Our energy modeling activities are focused on the development, support and application of LEAP: the Long range Energy Alternatives Planning System, a widely used software tool for energy policy analysis and climate change mitigation assessment (see below). In addition to developing LEAP and supporting LEAP users, we also apply LEAP in a wide variety of energy scenario studies, and we provide technical support and capacity-building services to policymakers and analysts in developing countries to help them devise mitigation strategies.

LEAP: the Long range Energy Alternatives Planning System

LEAP, the Long range Energy Alternatives Planning System, is SEI's widely used software tool for energy policy analysis and climate change mitigation assessment. LEAP has been adopted by hundreds of organizations in more than 190 countries. Its users include government agencies, academics, non-governmental organizations, consulting companies, and energy utilities. It has been used at many different scales ranging from cities and states to national, regional and global applications. This year has seen major efforts to develop a new version of LEAP, and to make the techniques built into LEAP available to a wider audience. The new version will include new least-cost energy planning capabilities (developed in partnership with the IAEA, the U.K. ERC and others), new techniques for modeling of seasonal and time-of-day variations in demand and supply (see graphic below), a revamped file format that will support use of the system by large teams of users, and a new web-based tool that will allow results to be uploaded to a web site for interactive viewing. The new version of LEAP (LEAP2011) is expected to be released in spring 2011, with the new web-based tool following shortly thereafter.

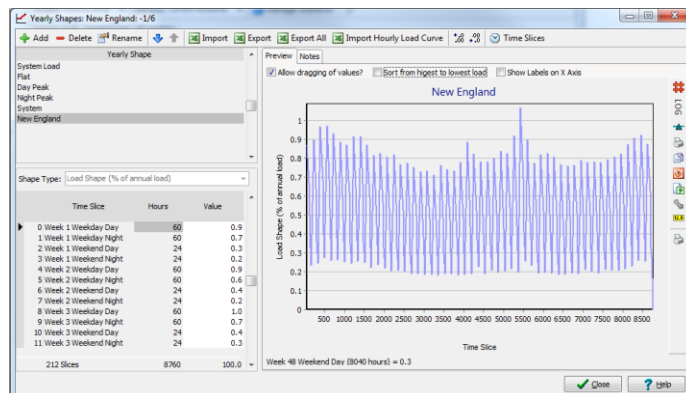
Client: SEI/IPS

Partners: U.K. Energy Research Centre (UK ERC), International Atomic Energy Agency (IAEA), Energy Research Center at the University of Cape Town (ERC, UCT).

Budget: \$50,000 (IPS)

Timeframe: 2001 - ongoing

Staff: Heaps, C.



Specifying Seasonal and Time-Of-Day Variation in Electric Loads in LEAP

COMMENT

COMMENT (COMMunity for ENergy environment & Development) is an international initiative managed by SEI and designed to foster a community among energy analysts working on energy for sustainable development. A premise of COMMENT is that institutional and human capacity for energy and environmental analysis is in short supply, and that Southern analysts are isolated from their colleagues in other institutions and from sources of institutional support in both the North and South. COMMENT is primarily a web-based initiative to provide technical support, but also encompasses workshops held around the world to train energy and environment professionals in the techniques needed for energy planning and greenhouse gas mitigation assessment,

particularly through the use of SEI's LEAP modeling software. Activities in 2010 included the dissemination of new "starter" LEAP data sets for 104 countries via the COMMEND website and the organization of numerous trainings including workshops in Argentina, the Bahamas, Benin, Cuba, Estonia, Indonesia, South Korea, Mexico, Mozambique and Paraguay. 2010 also saw the expansion of the program, with Tory Clark joining Charlie Heaps on the COMMEND team as a trainer and LEAP expert.

Clients: SEI/IPS, UNDP National Communications Support Program (NCSP) and others

Partners: Fundacion Bariloche, UNDP, various governments

Timeframe: 2002 - ongoing

Budget: \$50,000 (IPS portion only)

Staff: Heaps, C.; Clark, V.

Website: www.energycommunity.org



LEAP Workshop in Benin



LEAP Workshop in Mexico

Massachusetts Global Warming Solutions Act

The [Massachusetts Clean Energy and Climate Plan for 2020](#) (GWSA) requires the Commonwealth of Massachusetts to achieve GHG reductions of 80% by 2050. To help meet these goals, the State asked SEI to develop a new energy and climate mitigation model that examined what policies can best meet these targets. SEI used the LEAP model to create baseline emissions projections to 2020 and 2050 and also analyzed more than 50 different policies and measures that could be implemented to achieve these goals. These measures include major energy efficiency and technical measures such as the electrification of transport and deep energy efficiency retrofits of buildings as well

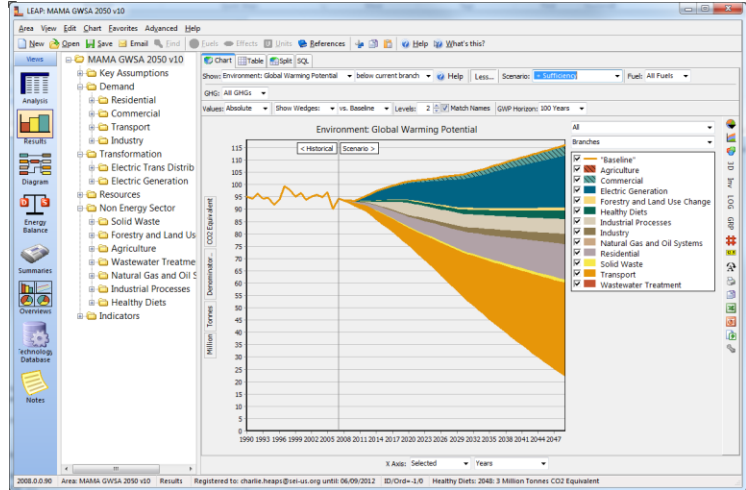
as dramatic shifts in how the state might generate carbon-free electricity. The modeling is being used to inform policymakers as they develop a plan for implementing the new GWSA law.

Client: State of Massachusetts

Timeframe: 2010 - ongoing

Budget: \$200,000 over 2 years (2010 and 2011)

Staff: Heaps, C.; Clark, V.



CLIMATE ECONOMICS

Much of the current debate about the economic costs of addressing the urgent climate change crisis is based on traditional economic analyses that largely ignore the ethical dimensions associated with the equally urgent problems of global under-development, inequity and poverty. Our climate economics program seeks to understand the inadequacy of current techniques and to develop and apply new models that can better address these twin crises. We also undertake studies examining the damage costs associated with inaction on climate change both in the U.S. and various regions of the world; analyzing interstate differences in U.S. greenhouse gas emissions and in the impacts of carbon price policies; and building consumption-based GHG inventory models at the U.S. state and county levels.

Western Water, Climate Change, and the Costs of Inaction

Several Western U.S. states are rapidly running out of water, and climate change is exacerbating the problem. This study analyzed the interactions of climate change with water, agriculture, and energy in the West and Southwest, making projections through the year 2100, with a special focus on California and less-detailed analyses for other states. Issues considered included increasing heat, a decline in snowfall and thus snowmelt, and competing demands for water for urban areas, irrigation, power generation, and environmental needs.

Client: Kresge Foundation

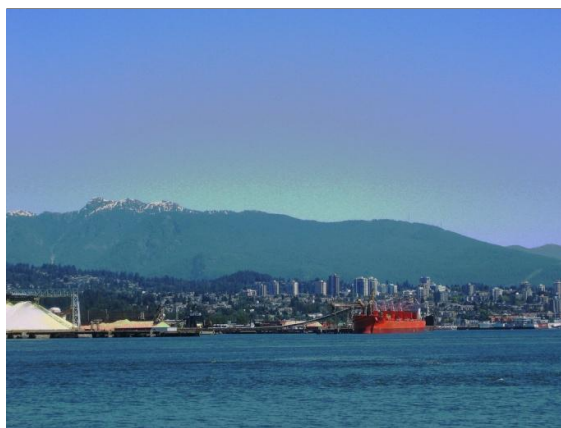
Timeframe: 2009-10

Budget: \$160,000 (including \$40,000 for Synapse Energy Economics)

Staff: Ackerman, F.; Stanton, E.A.; Fitzgerald, E.; Fisher, J. (Synapse Energy Economics); Davis, M.; Balasubramanian, J.

Costing Climate Impacts and Adaptation: A Canadian Study on Coastal Zones

This study, part of a broader national review of key issues in climate change mitigation and adaptation, looked at the potential economic impact of climate change on Canada's coastal zones. It introduced an innovative methodology that combined a physical model of climate-change-related sea-level rise and storm surges with detailed economic analysis. Damages were estimated cumulatively and annually, for 30-year periods centered on 2025, 2055 and 2085, looking at four possible scenarios, based on the environmental and economic policy choices made. It also considered the potential impact of two recommended adaptation measures: retreating from the most-exposed coastal areas, and curtailing development in the most vulnerable areas.



Client: National Round Table on the Environment and the Economy (Canada)

Timeframe: 2010

Budget: \$50,559

Staff: Stanton, E.A.; Fencl, A.; Davis, M.; Ackerman, F.; Bedig, A.; Bueno, R.; Fitzgerald, E.

Emission Reduction, Interstate Equity, and the Price of Carbon

Resistance to U.S. climate policy proposals has been based, to a great extent, on fears that it will cause economic harm, especially to states with carbon-intensive economies. This project examined the underlying differences between states that will determine how they are affected by climate policy and modeled the effects of carbon prices on households by income level and by state in a system that would return most of the carbon revenues to

households and target the rest to promoting energy efficiency and “green” development in coal-dependent states. The analysis also identified key questions by which to judge proposed climate policies.

Client: E3 Network

Timeframe: 2010

Budget: \$60,000

Staff: Stanton, E.A.; Ackerman, F.; Bueno, R.; Fitzgerald, E.; Davis, M.

Cost-Benefit Analysis vs. Coal Ash Regulation: A Critique of the RIA and Proposed Rule for Coal Combustion Residue

This project, designed to support testimony in the U.S. Environmental Protection Agency's rulemaking on coal combustion residues (coal ash), critiques the regulatory impact analysis (RIA) developed by the EPA and its use in the process. It replicates the RIA's economic analysis, identifies errors and flawed assumptions, and recommends improvements. It also specifically critiques the RIA's analysis of potential "stigma" effects of regulation, which not only presumes large, irrational market responses in one scenario, but could set a dangerous precedent by considering factors that have no legitimate role in the regulatory process.



Client: Earthjustice and Environmental Integrity Project (EIP)

Timeframe: 2010

Budget: \$80,000

Staff: Ackerman, F.; Stanton, E.A.; Davis, M.

Integrated Climate Economics Assessment

This project explores the integration of three SEI modeling frameworks for climate and development issues: CRED (Climate and Regional Economics of Development), LEAP (Long-range Energy Alternatives Planning system), and the Greenhouse Development Rights (GDR) framework. First, we linked CRED and LEAP and compared and integrated LEAP's estimates of the costs of emission reduction with the abatement cost function currently used in CRED. Second, we explored the connection between the CRED and GDR approaches to the problems of global equity and burden-sharing in international climate policy.

Client: SEI

Timeframe: 2010

Budget: SEK 750,000 (~ \$111,450)

Staff: Ackerman, F.; Heaps, C.; Kartha, S.; Bueno, R.; Stanton, E.A.

An Alternative Approach to the Social Cost of Carbon

The federal Interagency Working Group on the Social Cost of Carbon has proposed that the “social cost of carbon” (SCC) be estimated at \$21 per ton of CO₂ for policy purposes, based on averages of results from the DICE, FUND, and PAGE climate economics models. We have explored the economic analysis underlying this estimate and tested its sensitivity to alternate assumptions, such as lower discount rates; corrected damage estimates; alternative socioeconomic scenarios; and equity weighting of economic impacts by region.

Client: E3 Network

Timeframe: 2010 - ongoing

Budget: \$125,000

Staff: Ackerman, F.; Stanton, E.A.; Bueno, R.

CLIMATE MITIGATION POLICY

The threat of global climate disruption and the lack of basic energy services for billions of people call for a new energy transition. Clean and affordable energy technologies must be brought to the market, and energy policies and institutions must foster equitable development:

- We provide analytical support and facilitation to federal, state and local stakeholders who are developing comprehensive and innovative strategies to reverse GHG emissions growth in the United States.
- We offer technical support and capacity-building to policymakers and analysts in developing countries to help them devise mitigation strategies.
- We design and provide advice on implementing emissions inventories for cities, counties and states.

King County Greenhouse Gas Emissions Inventories and Tracking Framework

In the absence of an accepted, standard GHG inventory protocol for communities, King County and other partners have funded this ambitious project to recommend a greenhouse gas (GHG) emissions monitoring framework for the region of King County (which includes Seattle). SEI's work on this project has included compiling a 2008 update to the County's GHG emissions inventory (using traditional inventory methods) as well as conducting an innovative consumption-based GHG inventory (counting all the emissions released to support consumption in the county, regardless of where those emissions were released). Using results of these two inventories, coupled with additional research, SEI has been working with King County and other project partners to recommend a comprehensive, policy-relevant, cost-effective emissions measurement framework.

Client: King County Department of Natural Resources & Parks – Solid Waste Division

Partners: Cascadia Consulting Group Inc.; Gordon Smith, Ecofor LLC; Michael Gillenwater

Timeframe: 2010 - ongoing

Budget: \$110,000 (budget \$150,000 including partners)

Staff: Erickson, P.; Lazarus, M.; Stanton, E.A.; Chandler, C.; Bueno, R.; Ackerman, F.; Kollmuss, A.

Seattle Carbon Neutral Analysis

The City of Seattle has announced its intention to become a "carbon neutral" city. SEI worked with the City's Office of Sustainability and Environment to define what "carbon neutrality" might mean for a community and then to develop alternative scenarios for how Seattle might attain such an ambitious goal. The work involves developing baseline forecasts of Seattle's emissions growth out to 2050, exploring alternative definitions of carbon neutrality, assessing the relative spheres of influence of city government and other community stakeholders, and developing deep reduction scenarios. The modeling for this analysis was accomplished through LEAP.

Client: City of Seattle – Office of Sustainability and Environment

Partners: Cascadia Consulting Group Inc.; ICF International

Timeframe: 2010 - ongoing

Budget: \$69,000 [\$100,000 total including partners]

Staff: Lazarus, M.; Erickson, P.; Chandler, C.; Kollmuss, A.

Benchmarking Industrial Greenhouse Gas Emissions

In 2009, Washington Governor Christine Gregoire issued an executive order for the State Department of Ecology to develop greenhouse gas (GHG) benchmarks for the industrial sector. SEI conducted the first phase of research under the Department of Ecology's efforts - investigating issues and options for benchmarking industrial GHG emissions, including possible benchmarking methods, data sources, and policy approaches. The research culminated in a White Paper on industrial GHG benchmarking. The project also involved convening a benchmarking symposium, in coordination with the Western Climate Initiative, which was attended by over 100 representatives

from industry and state and national government. Ross & Associates Environmental Consulting, Ltd and German consultancy Oko Institut assisted by contributing to the stakeholder outreach and technical research, respectively.

Client: State of Washington Department of Ecology, Energy Foundation

Partners: Ross & Associates Environmental Consulting, Ltd; Oko Institut

Timeframe: 2010

Budget: \$50,000

Staff: Erickson, P.; Lazarus, M.

Life Cycle Assessment of Woody Biomass Management Options

We worked with the Olympic Region Clean Air Agency (ORCAA) to comprehensively analyze and quantify life-cycle air emissions of different options for using or disposing of woody biomass generated from forest management and land clearing operations in the Pacific Northwest. The report and spreadsheet tool we developed is intended to serve as a decision-making support tool to allow managers to balance multiple objectives, including air quality and GHG emission reductions, when selecting and approving options for woody biomass management.

Client: Olympic Region Clean Air Agency (ORCAA)

Partners: Gordon Smith, Ecofor LLC

Timeframe: 2009-10

Budget: \$85,062

Staff: Lee, C.; Erickson, P.; Hammerschlag, R.

Oregon Consumption-based GHG Inventory

We developed a consumption-based inventory of all greenhouse gases associated with the economy in Oregon (including emissions released to produce and transport goods made out of state). This pioneering effort, which is the first consumption-based GHG inventory for a U.S. state, aims to help Oregon policymakers better understand the state's contribution to global greenhouse gas emissions and design new strategies to address the emissions associated with consumption.

Client: Oregon Department of Environmental Quality

Timeframe: 2009-10

Budget: \$95,103

Staff: Stanton, E.A.; Erickson, P.; Bueno, R.; Ackerman, F.; Lazarus, M.; Hammerschlag, R.

ClimateWorks Evaluation

SEI contributed to an evaluation of the ClimateWorks Foundation, a global philanthropic network devoted to ensuring that the global average temperature does not increase by more than 2°C from pre-industrial levels. SEI's role focused on evaluating the underlying technical assumptions and analytical frameworks employed by ClimateWorks to assess the organization's priority initiatives.

Client: ClimateWorks Foundation, Ross and Associates, and Industrial Economics Inc. (IEC)

Timeframe: 2009 - ongoing

Budget: \$24,000

Staff: Lazarus, M.; Erickson, P.; Hammerschlag, R., Chandler, C.

Evaluation of sustainable development benefits of biomass energy project types

Recent literature has highlighted the shortcomings of the Clean Development Mechanism to deliver on its dual objectives of emission reduction and sustainable development. These studies have treated biomass energy projects as a broad category, even though they vary broadly in feedstock (from field residues to industrial residues and dedicated wood plantations), scale, technology, end use, and actors involved. SEI's analysis compared the sustainable development characteristics of different biomass energy project types. We focused our comparison on

registered CDM projects located in India and Brazil, the two countries that host the majority of biomass energy projects in the CDM pipeline.

Client: IPS Bio-resources, Climate and Development:

Timeframe: 2010

Budget: 180,000 SEK (\$22,300)

Staff: Lazarus, M.; Lee, C.

Water for Electricity Educational Webpages

The Union of Concerned Scientists (UCS) has a series of educational webpages devoted to energy technologies and climate change. In an effort to broaden the scope of these pages to the intersection of energy and water, SEI did the technical research for new web content detailing how water is involved in electricity, including fuel extraction, electricity generation and waste disposal. These webpages included how water is used in thermoelectric electricity generation (e.g. coal, natural gas, nuclear, solar thermal and geothermal systems) as well as in hydroelectric power plants.

Client: Union of Concerned Scientists

Timeframe: 2010

Budget: \$12,000

Staff: Clark, V.

Website:

http://www.ucsusa.org/clean_energy/technology_and_impacts/energy_technologies/water-energy-electricity-overview.html



EMISSIONS TRADING & OFFSETS

Greenhouse gas emissions trading is now a well-established market-based tool that can potentially help the world achieve significant emissions reductions in an efficient manner. However, GHG emission trading programs to date have yielded only modest environmental gains, their accomplishments limited by unambitious near-term targets, political compromises, and design flaws. SEI conducts research to strengthen the efficiency and environmental integrity of emission trading mechanisms. We work with policymakers and other stakeholders to better understand the real-world implications of design and implementation choices in emission allowance and offset trading systems. Through careful analysis, SEI's work offers solutions that can help these programs deliver emissions reductions at the scale and speed required.

Support to Western Climate Initiative - Offset Policy

The Western Climate Initiative is a regional collaboration between seven U.S. states and four Canadian provinces, representing over 70 percent of the Canadian economy and 20 percent of the U.S. economy, that aims to reduce greenhouse gas emissions by 15 percent below 2005 levels by 2020. SEI advised and supported the Initiative in the development of the program design to work towards putting the program in place to start on January 1, 2012.

Client: Western Climate Initiative, U.S. member states

Timeframe: 2006 - ongoing

Budget: \$111,000

Staff: Lazarus, M.; Lee, C.; Erickson, P.

Economics of International GHG Offset and Credit Mechanisms

SEI conducted an assessment of the economics of international crediting mechanisms, including standard offsets, sectoral mechanisms, and revised approaches to the CDM. We reviewed approaches to estimate the supply of credits, built a spreadsheet model of international offset supply, and applied this tool – as well as insights from our experience and research on the CDM, alternative finance mechanisms, and global mitigation potentials – to help assess international offset instruments and policy dialogues.

Client: Energy Foundation

Timeframe: 2009 - ongoing

Budget: \$75,000

Staff: Erickson, P.; Lazarus, M.

CLIMATE EQUITY

The emerging climate crisis must be seen against the backdrop of the equally urgent global development crisis. Our climate equity program seeks to understand the ethics and mathematics of these twin crises so as to develop a framework for helping policy makers and other stakeholders negotiate the problems of how to fairly share the burden of avoiding serious climate change impacts. This research has led to the development of the Greenhouse Development Rights (GDRs) Framework, a burden-sharing approach based on an ethical and transparent accounting of national responsibilities and capacities. The GDRs framework could provide the basis of a solution to the burden-sharing problem at the heart of the climate negotiating impasse. The concepts developed in the GDRs Framework have already been applied by SEI to examine the obligations of numerous nations, and have also been used to guide a series of climate mitigation studies. For more information on the GDRs Framework, please visit: www.greenhousedevelopmentrights.org.

The Greenhouse Development Rights Framework and Other Issues Relating to Equitable Burden-Sharing in the International Climate Regime

SEI has continued its work examining the relationship and potential tension between an ambitious climate response and development through its Greenhouse Development Rights Framework, a burden-sharing framework designed to safeguard developmental equity in a climate-constrained world. The work this year has included country reports, commentaries, political analyses, and quantitative analyses.

Client: Clipore (MISTRA), IPS

Timeframe: 2006 - Ongoing

Budget: ~\$120,000 (2010)

Staff: Kartha, S.; Kemp-Benedict, E; Athanasiou, T. (EcoEquity); Baer, P. (Georgia Institute of Technology)

SUSTAINABLE FUTURES

Investigating the potential for a sustainable future lies at the heart of all of SEI's work. However, some of SEI's projects are especially focused on longer-term change: large-scale and long-term studies; explorations of the prospects for a sustainability transition; and tools and techniques for thinking about the future. Our activities in this area have included the development and application of a series of scenario-based modeling systems including the PoleStar and IPAT-S tools, which support integrated long-range futures modeling across a broad array of topics related to sustainable development.

Scenario Analysis Working Group: CCICED Task Force on Ecosystem Service and Management Strategy

The goal of the Task Force is to enhance the contribution of ecosystem service management to the future sustainable development of China, with a particular focus on the sustainable management of forests, wetlands and grasslands, based on ecosystems services principles. The work aimed to improve the understanding of policy makers on the contribution of ecosystems services to national development and identified policies and actions at national, provincial and local levels that help sustain and enhance ecosystems services flows from forests, wetlands and grasslands.

Client: China Council for International Cooperation on Environment and Development (CCICED)

Partners: SEI Asia

Timeframe: 2010

Budget: \$21,000 (U.S. Center component)

Staff: Kemp-Benedict, E.; Li, L. (SEI Asia); Soussan, J. (SEI Asia); Liu, W. (SEI Asia)

Mekong Futures Project – Northeast Thailand

This project is part of a larger AusAID and CSIRO-funded project on Mekong Futures. The study designed an integrated framework for supporting decision-making for sustainable livelihoods in Northeast Thailand. As the most impoverished agricultural region, Northeast Thailand has been a top priority for national development schemes, which have improved household living standards dramatically. However, increasing energy and food demands are undermining sustainable land-use practices. The project team engaged with the existing decision-making process of River Basin Authorities to provide decision support in exploring long-term trends, challenges, and opportunities for the region.

Client: Commonwealth Scientific and Industrial Research Organization (CSIRO), Australian Agency for International Development (AusAID)

Partners: SEI Asia, University of Khon Kaen, CSIRO

Timeframe: 2010-12

Budget: \$27,672 (U.S. Center component)

Staff: Kemp-Benedict, E.; Mikhail, M.; Krittasudthacheewa, C. (SEI Asia); Polpanich, O. (SEI Asia)

Bioenergy, Sustainability and Trade-offs: Can We Avoid Deforestation While Promoting Bioenergy?

SEI and its collaborators assessed the potential impacts of bioenergy production on forests and forest-based livelihoods. The work focused on biofuel production for international markets. SEI developed and facilitated global and regional scenario exercises, and built on a previous SEI collaboration with CIFOR.

Client: European Commission

Partners: Center for International Forestry Research (CIFOR), Council for Scientific and Industrial Research (CSIR),



Universidad Nacional Autónoma de México, Joanneum Research

Timeframe: 2009-11

Budget: \$48,855 (U.S. Center component)

Staff: Kemp-Benedict, E.; Lee, C.; Resende, F.; Hammerschlag, R.; Johnson, F. (SEI Stockholm); Tella, I. (SEI Stockholm)

Participatory Scenarios for Smallholder Timber Plantations in Vietnam

SEI collaborated with the Center for International Forestry Research (CIFOR) and the Forest Science Institute of Vietnam to carry out a participatory scenario building workshop on trends pertaining to smallholder timber plantation development in Phu Tho and Binh Dinh, Vietnam, using data collected by CIFOR and partners.

Client: Center for International Forestry Research (CIFOR)

Partners: CIFOR, Forest Science Institute of Vietnam

Timeframe: 2010

Budget: \$10,000

Staff: Kemp-Benedict, E.; Huber-Lee, A. (Tufts University)



National Bioenergy Investment Model

SEI collaborated with the Center for International Forestry Research (CIFOR) and the Council for Scientific and Industrial Research of South Africa (CSIR) to create a national-level model that simulates the flow of investment funds toward different biofuel business models. The model helps regional policymakers to explore different policy instruments in order to meet policy objectives through biofuel development.

Client: European Commission, USAID, SIDA

Partners: CIFOR, CSIR

Timeframe: 2009-10

Budget: \$54,900 (of which \$39,200 to US Center)

Staff: Kemp-Benedict, E.; Lee, C.; Senyagwa, J. (SEI Africa); Vilchis-Tella, P. (SEI Stockholm); Webster, K. (Tufts University)

Assessment of Global Bioenergy Potential

Estimates of global bioenergy potential differ considerably. In an effort to better guide decision-making that may rely on these estimates, SEI conducted a review and assessment of these estimates to determine the primary drivers of the variation.

Client: Clipore Task 4.6: Bioresources, mitigation, and livelihoods

Timeframe: 2007-10

Budget: 210,000 SEK (\$26,000)

Staff: Lee, C.; Mikhail, M.; Kemp-Benedict, E.; Hammerschlag, R.; Lazarus, M.

SEI-US PUBLICATIONS 2010

Note: Articles published in late 2009 that were omitted from the 2009 Annual Report are also included here.

JOURNAL ARTICLES

Ackerman, F., Stanton, E.A. and Bueno, R. (2010). Fat Tails, Exponents, Extreme Uncertainty: Simulating Catastrophe in DICE. *Ecological Economics* 69:8, 1657–65. DOI:10.1016/j.ecolecon.2010.03.013.

Escobar-Arias, M. I., and Pasternack, G.B. (2009). A hydrogeomorphic dynamics approach to assess in-stream ecological functionality using the functional flows model, part 1 - model characteristics. *River Research and Applications* 26:9, 1103-1128. DOI:10.1002/rra.1316.

Escobar-Arias, M. I., and Pasternack, G.B. (2009). Differences in River Ecological Functions Due to Rapid Channel Alteration Processes in Two California Rivers Using the Functional Flows Model, Part 2 – Model Applications. *River Research and Applications* 27:1, 1-22. DOI:10.1002/rra.1335.

Flores-López, F., Easton, Z.M. and Steenhuis, T.S. (2010). A multivariate analysis of covariance to determine the effects of near-stream best management practices on nitrogen and phosphorus concentrations on a dairy farm in the New York Conservation Effects Assessment Project watershed. *Journal of Soil and Water Conservation* 65:6, 438–49. DOI:10.2489/jswc.65.6.438.

Joyce, B.A., Wallender, W.W., and Mailapalli, D.R. (2010). Application of Pesticide Transport Model for Simulating Diazinon Runoff in California's Central Valley. *Journal of Hydrology* 395:1-2, 79-90. DOI: 10.1016/j.jhydrol.2010.10.017.

Kollmuss, A; Lee, C; Lazarus, M. (2010). How offset programs assess and approve projects and credits. *Carbon Management* 1: 1, 119-134. DOI:10.4155/cmt.10.6.

Kemp-Benedict, E. ; Bharwani, S.; Fischer, M.D. (2010). Using Matching Methods to Link Social and Physical Analyses for Sustainability Planning. *Ecology and Society* 15:3, art. 4.

Kirby, M., Krittasudthacheewa, C., Mainuddin, M., **Kemp-Benedict, E.**, **Swartz, C.** and de la Rosa, E. (2010). The Mekong: A diverse basin facing the tensions of development. *Water International* 35:5, 573-593. DOI:10.1080/02508060.2010.514094.

Mikhail, M. (2010). Opportunities revealed by the Nepal multiple-use water services experience. *Waterlines* 29:1, 21-36. DOI:10.3362/1756-3488.2010.003.

Stanton, E.A., and Ackerman, F. (2009). Climate and development economics: Balancing science, politics and equity. *Natural Resources Forum* 33:4, 262-273.

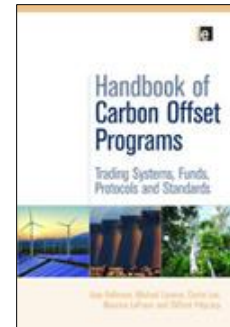
BOOKS AND BOOK CHAPTERS

Ackerman, F. (2010). Cost-Benefit Analysis of Climate Change: Where It Goes Wrong. In *Economic Thought and U.S. Climate Change Policy*, D.M. Driesen, ed. Cambridge, MA: The MIT Press.

Ackerman, F., DeCanio, S.J., Howarth, R.B. and Sheeran, K. (2010). The Need for a Fresh Approach to Climate Change Economics. In *Assessing the Benefits of Avoided Climate Change: Cost-Benefit Analysis and Beyond*, J. Gullledge, L.J. Richardson, L. Adkins, and S. Seidel, eds. Proceedings of Workshop on Assessing the Benefits of Avoided Climate Change, March 16-17, 2009. Arlington, VA: Pew Center on Global Climate Change.

Kartha, S., Baer, P., Athanasiou, T. and **Kemp-Benedict, E.** (2010). The right to development in a climate constrained world: The Greenhouse Development Rights framework. In *Der Klimawandel: Sozialwissenschaftliche Perspektiven*, M. Voss, ed. Wiesbaden: VS Verlag für Sozialwissenschaften.

Kollmuss, A. ; Lazarus, M. ; Lee, C. ; LeFranc, M. ; Polycarp, C. (2010). *Handbook of Carbon Offset Programs Trading Systems, Funds, Protocols and Standards*. Washington, DC: EarthScan Publications.



CONFERENCE PAPERS

Escobar-Arias, M. I., Mosser, C., Thompson, L., **Purkey, D.**, and Moyle, P. (2010). Water Management Adaptations for Aquatic Ecosystem Services Under a Changing Climate. Analytical Framework and Case Study for Chinook Salmon in California. AGU Fall Meeting, San Francisco, CA.

Escobar-Arias, M. I., Purkey, D., and Moyle, P. (2010). "Climate change and spring-run Chinook salmon in California: scenario analysis of flow and temperature changes for Butte Creek, California (Talk)." Bay Delta Science Conference, Sacramento, CA.

Pouget, J. C., M. Villacis, T. Condom, D. **Purkey, M. I. Escobar-Arias**, M. Calispa, R. Calvez, B. Caceres, L. Masincho, B. Francsou, and D. Paredes. (2010). Tropical Ice KISS Modelling and Water Resources Planning in Quito (Ecuador) - Comparisons between different glaciohydrological models on Antizana stratovolcano. Perth Conference - Global Change and the World's Mountains, Perth, Scotland.

Thompson, L., P. Moyle, D. **Purkey, M.** Allen Truan, **M. I. Escobar-Arias**, C. Mosser, and A. Engilis. (2010). Climate change and Butte Creek Spring-run Chinook salmon: Predictions and management options from coupled watershed and population dynamics models in ESA Annual Conference, Pittsburgh, PA.

REPORTS AND PAPERS

Ackerman, F. (2009). *Financing the Climate Mitigation and Adaptation Measures in Developing Countries*. United Nations Conference on Trade and Development G-24 Discussion Paper No. 57.

Ackerman, F. (2009). *Daydreams of Disaster: An evaluation of the Varshney-Tootelian critiques of AB 32 and other regulations*. Report to the California Attorney General 2009.

Ackerman, F. ; Stanton, E.A. ; DeCanio, S.J.; Goodstein, E.; Howarth, R.B.; Norgaard, R.B.; Norman, C.S; Sheeran, K.A. (2009). *The Economics of 350: The Benefits and Costs of Climate Stabilization*. Report commissioned by the E3 Network.

Ackerman, F. and Stanton, E.A. (2010). *The Social Cost of Carbon*. Report for the Economics for Equity and the Environment Network.

Ackerman, F., Stanton, E.A. and Bueno, R. (2010). *CRED: A New Model of Climate and Development*. UN/DESA Working Paper No. 96. New York: United Nations Department of Economic and Social Affairs. Also released (and further revised) as SEI Working Paper WP-US-1003.

de Bruin, A., **Mikhail, M.**; Noel S.; Barron, J. (2010). *AWM Interventions and Monitoring and Evaluation: Potential Approaches at the Watershed Level*. SEI Project Report.

- Erickson, P.; Lazarus M.,** Hermann, H. (2010). *Issues and Options for Benchmarking Industrial GHG Emissions*. White Paper. SEI with support from Öko-Institut and Ross & Associates Environmental Consulting Ltd. for the Washington Department of Ecology, June 30.
- Erickson, P. ; Lazarus, M.,** Kelly, A. (2010). *Estimates of Future Supply of International Greenhouse Gas Offsets: A Critical Review*. SEI Project Report.
- Erickson, P., Lazarus, M.** and Larsen, J. (2010). *The Implications of International Greenhouse Gas Offsets on Global Climate Mitigation*. SEI Working Paper WP-US-1106.
- Erickson, P., Chandler, C. and Lazarus, M. (2010). *Considerations of Global Equity and Burden-Sharing in Community-Scale Climate Action Planning*. SEI Working Paper WP-US-1008.
- Gang, F.; **Ackerman, F.**; Stern, N.; Edenhofer, O.; Xu, S.; Eklund, K.; Li, L.; Hallding, K. (2009). *Going Clean: The Economics of China's Low-carbon Development*. Joint report by SEI and the Chinese Economists 50 Forum.
- Kemp-Benedict, E. (2010). *Within Country Income Inequality in Multi-decade Scenarios*. SEI Working Paper WP-US-1002.
- Kollmuss, A.; Lazarus, M.; Smith, G. (2010). *Discounting Offsets: Issues and Options*. SEI Working Paper WP-US-1005.
- Kollmuss, A.; Lazarus, M. (2010). *Industrial N2O Projects Under the CDM: The Case of Nitric Acid*. SEI Working Paper WP-US-1007.
- Kollmuss, A. ; Lazarus, M. (2010). *Buying and Cancelling Allowances as an Alternative to Offsets For the Voluntary Market: A Preliminary Review of Issues and Options*. OECD Environment Working Paper No. 21.
- Lazarus, M. ; Lee, C. ;** Smith, G. ; Todd, K. ; Weitz, M. (2010). *Road-testing of Selected Offset Protocols and Standards; A Comparison of Offset Protocols: Landfills, Manure, and Afforestation/Reforestation*. SEI US Working Paper WP-US-1001.
- Lee, C., Erickson, P., Lazarus, M.,** Smith, G. and Olympic Region Clean Air Agency (2010). *Greenhouse Gas and Air Pollutant Emissions of Alternatives for Woody Biomass Residues*. Report for the Olympic Region Clean Air Agency (ORCAA).
- Schneider, L.; **Lazarus, M. ; Kollmuss, A.** (2010). *Industrial N2O Projects Under the CDM: Adipic Acid - A Case of Carbon Leakage?* SEI Working Paper WP-US-1006.
- Stanton, E.A., Ackerman, F.** and Sheeran, K. (2010). *Understanding Interstate Differences in U.S. Greenhouse Gas Emissions*. SEI Working Paper WP-US-1004.
- Stanton, E.A. and Ackerman, F. (2010). *Emission Reduction, Interstate Equity, and the Price of Carbon*. Economics for Equity and the Environment report.
- Stanton, E.A., Ackerman, F.** and Sheeran, K.A. (2010). *Why Do State Emissions Differ So Widely?* Portland, OR: Economics for Equity and the Environment Network.