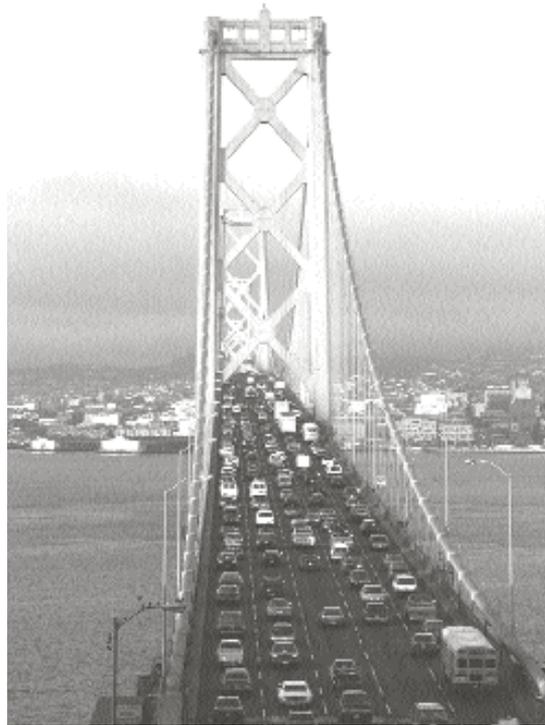




## *MIT/AGS hosts workshop on the automobile of the future*



*Photo courtesy Philip Greenspun, <http://philip.greenspun.com>*

About 60 sponsors and reviewers meet at MIT this fall to consider a report from the MIT/AGS project on Future Road Technologies. The workshop precedes the bi-annual meeting of the MIT/AGS Advisory Committee. The report – co-authored by MIT researchers, Dr. Malcolm Weiss, Senior Researcher in the MIT Energy Lab, Professor John Heywood, Director of the Sloan Automotive Lab, and Dr. Elisabeth Drake, Associate Director of the MIT Energy Lab – notes that in two decades, the typical US car could use a third less fuel than today’s typical car through evolutionary changes and without major increases in cost or rigid government requirements to reduce greenhouse gas (GHG) emissions.

The aim of this project has been a comprehensive assessment of new fuel and vehicle technologies for passenger car transportation with potential for reduced GHG and other emissions. The new technologies studied are those that could be developed and introduced commercially on a significant scale by 2020, particularly under governmental or consumer pressure for vehicles with lower greenhouse impact.

The project’s assessment considers the economic, environmental, and other impacts of each technology throughout its entire

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ENVIRONMENT and  
SUSTAINABILITY

*a quarterly publication of MIT's  
Center for Environmental Initiatives*

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## CALENDAR

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"Decision-making for brownfields redevelopment: The integration of technical, economic, environmental and legal issues" by Dr. Philip H. Byer (Univ. of Toronto), Wed., November 1, 12-1:30 pm, MIT, E40-496. Contact: Ms. Karen Gibson, 617-258-6368 (kgibson@mit.edu).

november

8

"The curious role of learning in climate policy: Should we wait for more data?" by Dr. Mor t Webster, Post Doc Fellow, MIT Joint Program on the Science and Policy of Global Change, Thurs., Nov. 8, 12-1:30 pm, MIT, E40-496. Contact: Ms. Karen Gibson, 617-258-6368 (kgibson@mit.edu).

november

29

"Public entrepreneurship: Understanding paths to sustainable technology development" by Dr. David Laws, Lecturer, MIT Department of Urban Studies and Planning, Wed., Nov. 29, 12-1:30 pm, MIT, E40-496. Contact: Ms. Karen Gibson, 617-258-6368 (kgibson@mit.edu).

january

14-17

"Shaping the future: Tools for sustainable development." Alliance for Global Sustainability Annual Meeting 2001, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland, January 14-17, 2001. For further information contact: Ms. Karen Gibson, 617-258-6368 (kgibson@mit.edu).

All events are held at MIT unless otherwise noted. For the most current listings, see the CEI website: <http://cei.mit.edu/>

Please send MIT sponsored event listings to Dr. Richard St. Clair, [stclair@mit.edu](mailto:stclair@mit.edu), phone 617-253-9871

system and life cycle – from raw materials in the ground to scrapped and recycled vehicles. Further, the impacts are considered in terms of the stakeholder groups, which include fuel manufacturers and distributors, vehicle manufacturers and distributors, government at all levels, and ultimately the consumers who purchase and use the vehicles.

Increased fuel efficiency could be achieved through incremental improvements in the vehicle body, the drive line, and the engine. However, if further improvements in fuel economy and reduction of GHG emissions were required by government, the study finds that they could be obtained by introducing new technologies in stages or in some combinations, all of which could drive up the baseline cost of vehicles by as much as 30% or more.

Two broad categories of new technology are (1) new "vehicle" technologies such as lightweight materials, reduced aerodynamic drag, and reduced rolling resistance, and (2) new propulsion system technologies such as hybrid systems and fuel cells. The study has focused largely on propulsion system technologies, but better vehicle technologies are seen as contributing significantly.

In the study, internal combustion engine (ICE) hybrid systems running on diesel, gasoline or natural gas were found to be highly efficient. Fuel cell hybrid systems using methanol or gasoline reformers or compressed hydrogen are less efficient than hybrid ICE systems on a life-cycle basis, but the differences are within the uncertainties of the results and depend on the source of the fuel. Fuel cell hybrid systems also can face the barriers of creating an acceptable fuel supply network, a problem with any new fuel (such as methanol or hydrogen) that is not a modest variant on existing petroleum fuels. Fuel cell hydrogen hybrid systems will also have to demonstrate the ability to store enough fuel on board to give acceptable range without compromising vehicle performance and capacity.

In the longer term, perhaps 20 to 50 years from now, the study considers vehicles fueled by the energy carriers – electricity and hydrogen – attractive as having the potential for significant further reductions of GHGs. However, those advantages will result only if electricity and hydrogen are produced from primary energy sources such as solar or nuclear, which emit little or no CO<sub>2</sub>.

Future research in this project will include extending its assessment to heavier vehicles such as vans and SUVs, which have high greenhouse impacts. It will also look at the transitional problems in shifting to new technologies and will identify the technical opportunities of greatest promise in developing longer-term technologies that offer further reduced environmental impacts. 

## *Knowledge assessment focus of second CEI/CIS workshop on credible data*

A central goal for public decisions about environmental and health risks is that those decisions rest – and are widely perceived as resting – on a minimally sound, unbiased base of available knowledge. A number of alternative institutional arrangements have been developed for assessing scientific information and incorporating that information into the regulatory process, but many observers still feel that US regulators fall short of making effective use of scientific and technical information when designing and revising regulations.

In March, MIT's Center for Environmental Initiatives (CEI) and Center for International Studies (CIS) brought together scientists and policy-makers to discuss the role of knowledge assessment in the policy-making process. Knowledge assessment is based on scientific information but incorporates empirical data from reviews of technology and economics. Several governmental and non-governmental bodies specialize in broad-based knowledge assessments. The workshop focused on six key organizations: the National Research Council (NRC) of the National Academy of Sciences; the Health Effects Institute (HEI); EPA's Clean Air Scientific Advisory Committee (CASAC); the H. John Heinz Center for Science, Economics, and the Environment; the National Institute of Health's Consensus Development Program (CDP); and the Office of Technology Assessment (OTA), a Congressional body that was disbanded in 1995. These organizations discussed procedures to insure that their assessments reflect the judgment of leading experts. All have enjoyed some success in achieving and maintaining credibility among a wide range of interested parties.

The workshop was led by Lawrence McCray, Research Affiliate at CIS, former head of the NRC Policy Division and leader of regulatory reform efforts in the Executive Office of the President. The workshop is part of the CEI/CIS study of sources of knowledge used in environmental decision-making processes. The study, in turn, is part of the MIT/AGS program on decision-making on environmental challenges. McCray organized the workshop as the first step in bringing together key participants from the supply and demand side of knowledge assessment. Thomas Grumbly, former Undersecretary of Energy and Executive Director of the HEI, served as moderator. Participants at the conference sought to examine how these bodies attacked similar problems and to extract the lessons that emerged from the practical expe-

riences of these knowledge assessment organizations in recent years. Senior representatives of all six organizations attended the conference.

Early in the workshop, the attendees heard from high-level decision-makers – representing the 'clients' of knowledge assessments – including prepared and impromptu remarks from Gilbert Omenn (former official in the Office of Science and Technology Policy [OSTP] and the Office of Management and Budget [OMB]), Robert Frosch (former NASA Administrator), Skip Johns (OSTP official), and Tom Grumbly (Department of Energy, Food and Drug Administration, Food Safety and Inspection Service). According to several of these policy experts, a major flaw in the knowledge assessment process was a lack of focus on actual policy questions. These decision-makers asserted that, instead of grappling with what policy-makers need to know, assessors frequently migrate toward issues that are of contemporary interest within the research community. Boyce Rensberger, director of the Knight Science Journalism Fellows program offered insights into the media's perceptions of knowledge assessment organizations and the difficulty of discerning the credibility of reports from organizations (aside from the National Research Council).

Bringing scientific information to bear in the policy process is not an easy task. Knowledge assessors at the conference repeatedly stressed their deeply held concerns for improving decision-making even while acknowledging the constraints under which these assessments operate. Though they worked in environments where others sought to use the products of knowledge assessment for political purposes, the participants at the conference sought to introduce information into the political process, in the hopes – but not under the delusion – of making policy a bit more grounded in the best available science.

Not surprisingly, it was found that the use of scientific information in policy settings is often less than ideal and manages to inspire controversy. The conflicting obligations of knowledge assessors on politically sensitive issues (*i.e.* "third rail" policy problems) were a major source of debate. On the one hand, the potential corruption of even a single policy question has implications for the broader credibility of the entire knowledge assessment process. However, an organization that builds up reservoirs of credibility with the public, the media and the political establishment can survive the politicization of a controversial topic. For example, NIH's CDP was undoubtedly damaged by the debate over its position which advised against women between the ages of 40 and 50 receiving a mammogram for screening purposes. Nonetheless, the CDP has survived and was widely noted by other participants for its novel, quick turnaround approach to assessment and its abili-

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# Can climate models predict the collapse of the North Atlantic circulation?

## An interview with Professor Peter Stone, MIT

One of the more compelling results of projections of climate change over the next few centuries, made with the best models available, is that the large scale circulations in the North Atlantic Ocean may collapse. The projections are based on a global warming scenario in which increases in greenhouse gases lead to increases in mean global surface temperatures. If that were accompanied by a collapse of the ocean circulation, then the loss of the heating due to the ocean circulation in northern Europe might overwhelm the global warming and northern Europe could go into a deep freeze. Scientists are indeed anxious to know if and when that might happen.

Experiments at MIT in ocean modeling attempt to project how rapidly the circulation might collapse, depending on the initial state from which the model is run. Even small differences in the initial state can have a big effect on when, or even if, the circulation might collapse. The following interview with Professor Peter H. Stone of MIT's Department of Earth, Atmospheric and Planetary Sciences attempts to shed light on how scientists are grappling with this and related problems of global climate change.

*Initiatives in Environment and Sustainability:* Professor Stone, how realistic are projections such as the possible collapse of the North Atlantic circulation?

*Peter Stone:* First, it is very important to realize that there are many gaps in our understanding of climate processes and how they affect projections of climate. All these gaps need to be attacked and removed before we can have confidence in the projections of climate change. There are lots of problems with the climate models that we currently have. One is that even the biggest, fastest computers we have available cannot calculate all the important physical processes. They have to make approximations and treat some of these processes very crudely because of the lack of computer power. That means that they are only going to be able to simulate these processes correctly if you have a very good understanding of them, and

in many cases we don't.

*IES:* When you say that according to these models the North Atlantic circulation will collapse at some point  $x$  years in the future, did you come up with this possibility by running models, or did you suspect that that would be so for other reasons?

*PS:* This possibility was first shown by very simple models as long as 35 years back. But nobody took it very seriously until the more sophisticated climate models were used, where you couple a three-dimensional atmospheric general circulation model with a three-dimensional ocean general circulation model, and run it with a global warming scenario.

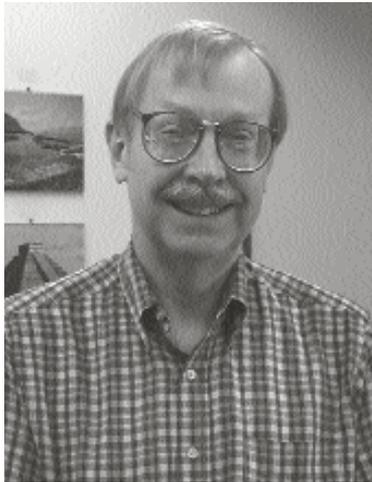
*IES:* What is the theory behind the projection of possible collapse of the North Atlantic circulation?

*PS:* When you have global warming due to, say, increases in  $\text{CO}_2$ , global temperatures rise. The  $\text{CO}_2$  is well mixed globally. You get warming in low and high latitudes as a result of that. This warming increases the evaporation from the ocean surface and the amount of moisture in the atmosphere. This in turn increases the mixing of moisture from low latitudes [nearer to the equator] to high latitudes [nearer to the poles] by winds in the atmosphere. As a result, you get more precipitation in high latitudes, which freshens the water – that is, it tends to reduce its density. In some of our experiments, this effect is strong enough that it reduces the amount of sinking in high latitudes and ultimately suppresses the ocean circulation. Just *when* it completely collapses in our model simulations varies from one experiment to another. In one, it's about 230 years, and about 500 years in another – and that difference is solely because of different initial weather conditions put into the model.

*IES:* Why do weather variations create differences in the projections?

*PS:* Fluid systems like weather in the atmosphere have in many cases what is known today as “chaotic” behav-





*Professor Peter Stone, MIT*

ior, which means they are not strictly predictable. The atmosphere and the ocean are key portions of the climate system and they are both fluids. Both winds in the atmosphere and currents in the ocean transport heat in motions which are highly turbulent and very difficult to represent accurately in a computer. We worry about the possibility of fluctuations in global temperatures over periods of, say, fifty to a hundred years that may be much larger than a few tenths of a degree just because of the natural variability of the system and have nothing to do with anthropogenic [*i.e.* human-caused] changes. And we don't know how big those fluctuations can be. If you look at the paleo-climate record, going back thousands and hundreds of thousands of years, there are major fluctuations in ocean circulation that have nothing to do with anthropogenic effects.

*IES:* So, you are saying, then, because of chaotic behavior in the atmosphere and oceans, that you can't predict when the circulation will collapse?

*PS:* If this chaotic component is strong, we won't be able to predict it. We really need to look at this problem with a more sophisticated model. This is the kind of behavior that we want to assess. To what extent can we *not* predict the collapse of that ocean circulation? To what extent can we really say what *might* happen 100 years from now?

*IES:* What causes chaotic behavior?

*PS:* It's a fundamental feature of the equations that describe fluid motion. The equations are highly nonlinear, and it's nonlinear systems that can have this behavior. The chaotic behavior results because these equations are very sensitive to initial conditions, so sensitive that you would never be able to make a projection beyond a certain time.

*IES:* Is there data to support the projection of collapse of the North Atlantic circulation?

*PS:* The best data is the paleo-climate data—sediment cores from the bottom of the ocean, for example, or ice cores in the polar ice caps. In this case there's pretty good evidence that, in past climate history, these circulations that transport so much heat have been turned on and off quite frequently. Accompanying this are data showing temperature changes in Greenland on the order of 10 degrees Celsius over periods of decades. This shows us that there is reason to take it seriously. But whether it will happen and at what point it would happen is very uncertain.

*IES:* What obstacles are there to getting a good climate model?

*PS:* The main obstacle to an efficient climate model lies with the atmospheric models. Here at MIT, [Professor] John Marshall and some of the staff of our Climate Modelling Initiative are trying to do the same thing for an atmospheric model that they did for our ocean model, namely, make it very efficient computationally for running on a multi-processor computer. They can take advantage of the work they did for the ocean because the dynamics, or the equations of motion, are basically the same for the atmosphere and the ocean. But, if you want to keep it realistic, you also have to worry about the physics that you put into the model. If you want a really good atmospheric model, you have to redevelop the physical codes, and that's not easy; it takes time.

*IES:* Considering the chaotic component in the atmosphere and oceans, how convinced are you of global warming from anthropogenic causes?

*PS:* I myself am convinced that anthropogenic factors have contributed to the global warming, but the really hard thing to pinpoint is how much of the warming of the last hundred years is due to increases in greenhouse gases as opposed to natural variability. I have another project that I'm involved with that is part of the Joint Program on the Science and Policy of Global Change [at MIT], where we've been looking precisely at this issue, and we've been trying to quantify it using objective techniques. We haven't actually completed the analysis, but I can give you a preliminary estimate. It looks as though we can say with about 80% confidence that at least about half of the warming [over the past century] is due to increases in greenhouse gases.

*IES:* Could the natural variability have a greater impact than anthropogenic causes on climate change over the

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next 100 years?

*PS:* Potentially, yes. Certainly we've seen that in paleo-climate data.

*IES:* But within the past, say, hundred years, can you find that degree of change?

*PS:* Well, if you go back hundreds of years, yes. There are episodes like the Little Ice Age, where there were major changes in the climate of northern Europe and in the climate of Greenland. There were major changes in the amount of sea ice in the North Atlantic, and this occurred on timescales of a few centuries. This cooling came in around 1400 and started to go away around 1800. And one of the things that we don't know is whether perhaps we're still emerging from that. Maybe the global warming of the last hundred years to a certain extent is just due to the rebound. There's a lot of controversy over exactly what has happened over the last hundred years.

*IES:* Is it possible with the tools that you have now to determine natural change as distinct from anthropogenic?

*PS:* Ideally we need observations that tell us what the true natural variability is, and those observations don't exist. The only thing we have to go on is models. So again, you need the best models you can get. But even if you assume that the current models are good enough to look at their natural variability as a proxy to true natural variability, the models are too inefficient computationally to look at some of these questions. That's because, to look at these questions, you need very long simulations – thousands of years – and the most sophisticated models are just too slow to do the big, long integrations. That's why we're trying to develop a more efficient atmospheric model.

*IES:* What value has been added to your work by the participation of the Alliance for Global Sustainability?

*PS:* Certainly they funded our work on developing new, more sophisticated land ice models: That's something that nobody was doing, and that's something that was really stimulated by the AGS. If it hadn't been our talking particularly with the people [at the Swiss Federal Institutes of Technology] in Zürich, it wouldn't have occurred to us to do that. They had the expertise on ice modeling, we had the expertise on global climate modeling, and it was only in a sense being thrust together through the AGS mechanism and discussing things that we found, that this would be a great opportunity to take their expertise and our

expertise and put them together to come up with better projections of sea-level changes. So it was very explicitly stimulated by the AGS knocking our heads together. And once we have that [the land ice models], it becomes an automatic component of all our climate models in the Joint Program and our Climate Modeling Initiative. So, forever after, whenever we make a projection, we'll automatically have as one output the sea-level rise, and in turn, a much more valuable projection.

*IES:* What would be an ideal climate model?

*PS:* You want a full climate model where you have atmosphere, ocean, land ice, sea ice, and biosphere all coupled together, and which reproduces the current climate and ideally the climates as we know them from the paleo-climate data, and it's probably not going to be that simple. If our models could explain the fluctuations in the last major ice ages, that would give us a lot more confidence in our models' projections over the next hundred years.

*IES:* So, to achieve that, you want to define the areas of uncertainty—you want to pin down specific areas so that you can tackle them systematically?

*PS:* That's right; we need to identify the areas that need improvement most. Some of the work that we're doing in the MIT Joint Program on the Science and Policy of Global Change is looking at how much of the warming of the past was due to increases of greenhouse gases as opposed to, say, natural variability. That very much relates to defining what the modeling uncertainties are, and that work is helping us to actually give a probability distribution for our projections. That same distribution of projections can then be run through land ice models such as Veronique Bugnion has developed at MIT through funding by the Alliance for Global Sustainability [see story, *this issue, page 8*].

*IES:* How long do you think it will be before we can make projections of climate change 100 years ahead with confidence?

*PS:* Scientists working on this problem implicitly assume that climate is predictable that far ahead, but, because of the presence of chaotic elements, this is not guaranteed. Before I can even attempt to answer your question we will have to gain a much better understanding of these elements and what limits they place on our ability to predict climate. The best that we may be able to do is to predict, for example, that the North Atlantic circulation has a certain probability of collapsing within a given time frame. 

## *Mexico City air quality short course draws international attention*

On June 1-9, a course on the science, technology, policy, human health impacts and mitigation options of urban air quality in Mexico City was presented by the Integrated Program on Urban, Regional, and Global Air Quality: A Mexico City Case Study. The Mexico City Project is the first of its kind to take an integrated, multidisciplinary look at the air quality management problem in Mexico City. The project looks at all the different factors – human health, science & technology and policy issues – and considers them as one integrated picture.

This course, which was presented by an international group of leading experts in air quality science and policy from Mexico, the US, Switzerland, and Germany, was attended by approximately 40 people from Mexican governmental agencies, industry, the media, and non-governmental organizations. Representing MIT were Institute Professor Mario Molina, Dr. Luisa Molina, and Dr. Matthew Gardner, Education Coordinator for the Center for Environmental Initiatives.

The primary intent of the course was to build capacity among decision-makers and stakeholders, so that they more fully understand the breadth and complexity of the air quality management problem in the Mexico City metropolitan area. The course illuminated the areas where more research is needed and where more attention needs to be paid in order for truly viable and long-lasting solutions to be found. Instructors gave a series of highly interactive presentations which were designed to provide many opportunities for interaction with the participants.

The short course is one of the first to present these different topics to an audience of true stakeholders and decision-makers who are faced with the major problem of air quality management in a large urban area such as Mexico City. The course has opened doors for continuing interactions and solidifying relationships between the participating organizations and agencies beyond the confines of the one week session. Plans are already in place to develop a whole other series of courses, seminars and workshops based upon the research this project is doing.

One of the key pillars of the Mexico City case study is that it is being performed in such a way that the methodologies are applicable to other developing megacities

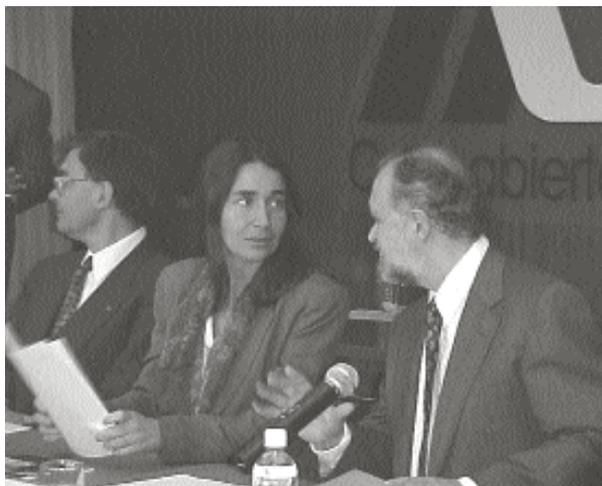
around the world. While solutions are being sought for Mexico City's air pollution problem, much of the information being generated by the case study is directly transferable to other congested and polluted megacities, such as Lagos, Nigeria; Bangkok, Thailand; and a number of large cities in China. The project is studying a wide range of air pollutants that include the greenhouse gases as well as more immediately toxic substances. Further, it is taking a detailed look at how industry and other economic dri-

*The Mexico City Project is the first of its kind to take an integrated, multidisciplinary look at the air quality management problem in Mexico City.*

vers and policy decisions impact local and regional air quality, and then linking these findings to the broader problem of global air quality. One of the most significant outcomes of the course was the fact that many of the participants who are responsible for managing air quality in Mexico City in one way or another were meeting and interacting for the first time on pressing environmental issues they have in common.

Following an introduction by MIT Institute Professor Mario Molina, John Evans of the Harvard Center for Risk Analysis spoke on air pollution and comparative risk assessment. The human health impacts of air pollution were presented by Joseph Brain, from the Harvard School

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*R-L: Prof. Mario Molina with Dr. Julia Carabias, Head of the Ministry for the Environment, Natural Resources and Fisheries, and Prof. Luis Mier y Terán, Dean of the Metropolitan Autonomous University, Iztapalapa*

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of Public Health, Peter Gehr, from the University of Bern, and Mauricio Hernández, of the Instituto Nacional de Salud Pública, México. Policy issues associated with air quality management were presented by Henry Lee, of the JFK School of Government at Harvard University, Jason Grumet, Director of the Northeast States for Coordinated Air Use Management (NESCAUM), and Stephanie Benkovic, of the US Environmental Protection Agency.

Judy Chow and John Watson of the Desert Research Institute spoke on the theory, practice, and state-of-the-art techniques of inventorying emissions. Air quality modeling methodologies and tools were presented by Francisco Guzmán and others from the Mexican Institute of Petroleum, Gary Whitten of ICF Kaiser, and Renate Forkel, from the Fraunhofer Institute in Germany. The final two days were occupied with discussions regarding the highly challenging subject of environmental negotiations, led by William Moomaw of Tufts University and Paul Levy from the Harvard Medical School.

A session on environmental negotiations and how people negotiate agreements on environmental topics introduced to the participants the necessary information about tools they need to bring to the table stakeholders who have widely disparate sets of interests. This is so the stakeholders can start talking about ways that they can come to agreements and negotiate new policies, regulations and practices in order to start to effectively address the air quality problem.

The leaders of various Mexican environmental agencies, universities, and research organizations and foundations attended the opening and closing sessions of the course. At the closing ceremony, the head of SEMARNAP – the Mexican counterpart to the US Environmental Protection Agency – praised the course as being a model for new interactions that will help to bring solutions to the air quality problems faced by many of the world's developing megacities.

After the end of the course there was a two-day follow-on workshop for the research project teams. The workshop is a bi-annual event for updating research results and mapping the future activities of the program. The complete research teams from Mexico and the US joined the course organizers in Cuernavaca, Mexico for two days of detailed progress reports and strategy sessions for future research plans. Many graduate students and postdoctoral researchers attended this workshop along with other faculty from the US and Mexican universities. 🌐

## *Projecting Sea Level Change by Modelling the Polar Ice Caps*

MIT graduate student Veronique Bugnion is a member of a research team that has been using models to investigate sea-level changes, which are recognized as one of the major potential impacts of climate change on society, since many people inhabit coastal zones around the world. In particular, very modest increases in sea level can lead to significant increases in the amount of high water accompanying storm surges and can, in turn, cause substantial increases in erosion, property damage, and even loss of life. Common scientific knowledge has it that the sea level will rise with increasing climate change. This is due to the so-called thermal expansion, the simple fact that warmer ocean water will take up a greater volumes. Concern is building, particularly in low-lying nations such as Bangladesh and Pacific islands in the Association of Small Island States, that storms associated with higher levels of the ocean will be even more destructive than they have been in the past.



*Veronique Bugnion, MIT*

Currently, there is much uncertainty in the projections of sea-level rise. Predictions, reported by the Inter-governmental Panel on Climate Change (IPCC) (*Climate Change 1995, The Science of Climate Change*, ed. J.T. Houghton *et al.*, Cambridge University Press, 1995) range from a rise of 38 cm to 55 cm (about 15 to 22 inches) in the level of the oceans by the end of the 21st century. However, MIT graduate student Veronique Bugnion points out that these predictions usually fail to include the effect that

melting ice or snowfall accumulation has on the level of the oceans. One major source of uncertainty is how the polar ice sheets and mountain glaciers respond to given changes in climate.

Making accurate projections of sea-level rise requires good knowledge and models of all the different components of the climate system that determine temperature, precipitation, and how the land-ice components of the system respond to changes in these quantities. An Alliance for Global Sustainability project involving Prof. Atsumu Ohmura's climate modelling group at the Swiss Federal Institutes of Technology (ETH) in Zürich and Prof. Peter H. Stone's group at MIT has sought to look at this question. ETH has developed a strong expertise in the study of ice, in general, and glaciers, in particular. Through this project AGS researchers have set out to develop more sophisticated models of the mass balance of the world's glaciers and ice sheets and to couple them to the climate models being developed at the three Alliance universities (ETH, MIT, and the University of Tokyo). The coupled models will be used to make projections of sea-level changes over the next century which projections, it is hoped, will have less uncertainty than those made to date.

The ETH climate modelling group is looking at the effect of climate change on some 20,000 glaciers around the world. Glaciers in the Alps and in Alaska, for example, have been observed to be retreating dramatically in recent years. But there are also documented cases of glaciers advancing--in Scandinavia, for example. The MIT group decided to build on the work of the ETH group in numerical modelling to look at the effect of climate change on Greenland and Antarctica. The idea was to create a model to cover those two ice sheets with a grid and to observe the evolution of the amount of snow falling at the surface and of melting and freezing in the snow cover at each point on the grid, over the next 100 years.

The MIT initiative has found two major, competing effects that have an impact on changes in sea-level. The first and more intuitive effect is that more ice will be melted at the margin of the Greenland ice sheet, thereby causing the sea level to rise. However, this situation does not apply to Antarctica, where temperatures are too cold to allow very much meltwater runoff to take place. Even after a century of climate change, the meltwater which is produced there would refreeze in-situ inside the snow cover. The second of these effects is that a warmer atmosphere has the capacity to transport more moisture: this, in turn, produces more snowfall, notably

*The surprising result of this study is that the effect in Antarctica outweighs the effect in Greenland. The models indicate that the combined effect of both ice sheets will actually be to decrease the level of the oceans by 4-5 cm. over the next century.*

over the poles. While the first effect dominates in Greenland, under most climate change scenarios, the second effect dominates in Antarctica.

The surprising result of this study is that the effect in Antarctica outweighs the effect in Greenland. The models indicate that the combined effect of both ice sheets will actually be to decrease the level of the oceans by 4-5 cm over the next century. Because of the offsetting effect of the two ice sheets, Ms. Bugnion observes, the uncertainty in this projection is smaller than for each ice sheet taken individually. She says, "The stronger the warming in the projected scenario, the more Greenland tends to melt and the more Antarctica tends to accumulate [*i.e.* through snowfall]. Although Antarctica 'wins out,' the offsetting effect of the two ice sheets tends to make the net effect less dependent on the precise warming scenario." This relative decrease in the level of the oceans, Bugnion says, is expected to offset about 25% of the rise due to thermal expansion calculated by the Joint Program on the Science and Policy of Global Change at MIT, or between 5-15% using the IPCC's figures.

For further information on these research projects see the AGS site at <http://curricula.mit.edu/cei/AGSprojects/globalchange-1.html> ("Predicting Sea-Level Changes Over the Next Century"). 

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ty to assess the impact of its own reports in a methodical manner. By contrast, the NRC, given its subordinate role within the National Academies and the fact that its very credibility derives from the elite of the National Academies, was seen as consistently avoiding controversy in deference to concerns of members of the National Academies of the NRC becoming even remotely politicized. As the most visible setback, the Office of Technology Assessment was represented by a number of alumni who now populate other knowledge assessment organizations.

Another thorny issue for knowledge assessors is the need for consensus. Policy-makers would prefer clear findings even though the scientific evidence will inevitably involve a significant degree of uncertainty. Some knowledge assessment organizations allow for reports to describe the reasons that consensus could not be reached. The NIH conferences do allow for a minority report to be issued, although this has occurred only three times in over 120 studies. NRC also allows for a process of voicing dissent, although the overall process itself seemed to foster unanimity and moderation over dissension and extreme views. By contrast, many of the newer institutions, which have focused exclusively on more controversial issues, seem always to require consensus. While consensus was recognized for its ability to instantly convey credibility to policy-makers and the public, comments were made about the dangers of relying on consensus – including delays in taking action and the ability of conservative elements to hold up majority, even widespread, agreement.

Most conference participants seemed to feel that credible knowledge assessments are too rarely performed. At the same time, they confronted the uncomfortable fact that the sector represented by the six organizations is not growing, and – with the demise of OTA – has even contracted.

The conference's finale, a roundtable discussion, highlighted the many insights gained by treating knowledge assessors as a group, and suggested topics for future work. Successful knowledge assessment organizations have managed to eliminate conflicts of interest, avoid capture, introduce openness into the deliberation process, and maintain a consistent institutional attitude. Participants agreed that each organization's credibility rested on its track record, and that each institution would be judged based on its success in capitalizing on these desirable traits. Unfortunately, there are tradeoffs among the elements that lead to credibility (increased openness, for example, may expose a group to charges of capture); thus, not all dimensions can necessarily be "improved" indefinitely. However, knowledge assessors and their clients agreed on both the novelty and the usefulness of considering the different organizations as a group. A follow-up workshop building on the initial discussions is being planned. 🌐

## *First Youth Environment Summit held in Switzerland*

The Alliance for Global Sustainability (AGS) Task Force on Environmental Education hosted the first Youth Environmental Summit (YES) in Braunwald Switzerland, August 13-26. This meeting brought together approximately 30 graduate students from 12 countries to discuss ways in which Agenda 21, the UN framework for sustainable development, can be implemented in both developed and developing countries. The participants, who were invited to participate through a competitive selection process, came from Switzerland, Japan, the United States, Mexico, Germany, Ivory Coast, Malaysia, Thailand, Singapore, Taiwan, Latvia, and India.



Approximately 20 AGS and guest faculty contributed to this gathering, including representatives of the World Business Council on Sustainable Development and the United Nations Environment Program. The program included seminars, interactive discussions, workshops, research projects, and role-playing exercises. The instructors represented the three partner institutions of the AGS, as well as other European and American universities. In addition to the activities in Braunwald, the participants went on several field trips to a hydroelectric facility, the Paul Scherrer Institute, EAWAG (the Swiss Federal Water Research Institute), and Geberit, a manufacturer of plumbing fixtures and supplies and a leader in sustainable manufacturing processes. The topics covered in the workshop ranged from the role of science and technology in sustainable development, financial and economic issues, transportation and mobility, energy production and usage, and food and water.

The YES was conceptualized in January 2000 at the AGS annual meeting at MIT, and was the result of months of design and planning by a core team of AGS researchers and staff members. The seminars were designed to provide the participants with basic background information on the multitude of issues relevant to sustainable development. This

knowledge was applied in research projects that were carried out by the participants in international teams and was then presented to the workshop participants and facilitators. The research projects included an examination of sustainable practices in industries, the development of a vision of the sustainable community of the future, the design of a technological framework for collaboration at a distance, a list of criteria for sustainable practices in government and society, grassroots education about sustainability, and a look at the e-commerce revolution and the implications it has for sustainable development.

The three partner institutions of the AGS have a solid track record of producing graduates that assume positions of leadership in the world's corporations, policy-making bodies and non-governmental organizations. The intention of the YES is to provide a forum where this next generation of leaders can learn the critical tools, techniques, and philosophies of sustainable development. Planning for the next YES event is underway. 

## *Environmental Fellows retreat*

On September 24-25, a weekend retreat was held for all the current Environmental Fellows at MIT, which include the Martin Family Society of Fellows for Sustainability for 2001-01, the Wallenberg Fellows, and the Camille and Henry Dreyfus Postdoctoral Fellow. The retreat, which was held at the Marine Biological Laboratory in Woods Hole, Massachusetts, allowed the fellows to get acquainted with each other and to spend some time discussing issues about the environment and sustainability in a relaxed setting early in the fall semester.

The topic of this retreat focused on the status of the world's fisheries. Because nearly the entire world's commercially important fish stocks are currently over-exploited, much attention is being given to the status of the world's fisheries and to the steps that need to be taken to make the utilization of these resources more sustainable. During the retreat, the fellows participated in seminars, discussions and tours about the important issues and about possible solutions to the problems. The Environmental Fellows at MIT are engaged in environmental research of various types. Interesting interactions took place owing to the diversity of interests and the varied background of the Fellows.

Professor Adil Najam of Boston University, a graduate of MIT's Technology and Policy Program and Department of Urban Studies and Planning, led a lively discussion on the basic issues of sustainability, particularly focusing on the issues faced by developing nations. In addition, Professor Andrew Solow and Dr. Porter Hoagland of the Woods Hole

Marine Policy Center led a two-part discussion which addressed some of the origins of the over-fishing problem, the basic economics and metrics of fisheries, and the prospective for the future of the fishing industry.

In addition to the discussions, the Fellows took tours of the Marine Resource Center at the Marine Biological Laboratory where many of the organisms that are utilized in fundamental research projects are raised. They also toured the Woods Hole facilities, including the research vessels, workshops and laboratories, and the National Oceanic and Atmospheric Administration (NOAA) Fisheries Center. At the NOAA facility the fellows participated in a discussion with staff from the federal agency regarding the history and future of fisheries regulations and management.

Each year, a retreat that focuses on a single topic or theme will be organized for the Environmental Fellows at MIT. Topics under consideration for the next retreat include sustainable forestry, organic farming, aquafarming, and ecotourism.

## **Martin Fellows for 2000-01 named**

Twenty graduate students at MIT have been named Fellows for 2000-01 in the Martin Family Society of Fellows for Sustainability. The Fellowship provides a forum for graduate students to meet regularly to discuss their research and explore the multi-disciplinary nature of environmental and sustainability issues. They also participate in events sponsored by the Alliance for Global Sustainability (AGS) coordinated by MIT, the Swiss Federal Institutes of Technology (ETH), and the University of Tokyo.

In previous years, eighteen fellows were named for 1999-2000, sixteen for 1998-99, and twenty-four for 1997-98, bringing the total this year to 76 fellows from the program's inception. Generous funding from the Martin Foundation, Inc., founded by Lee and Geraldine Martin, supports the Fellowship program. Under its support, the MIT Council on the Environment inaugurated the Martin Family Society of Fellows for Sustainability in 1997.

The Martin Fellows this for 2000-01 are: J. Sam Arey (returning from last year), Kaeo Duarte, Gavin Gong, Karim Karam, Julie Kiang, Megan Kogut, Brian White, Binita Bhattacharjee, Michael Timko, Chia-Chin Cheng (returning from last year), Brian Zuckerman, Rebecca S. Dodder, Michele Ferenz, Zhiqiang Zhai, Galen McKinley, Arnico K. Panday, Bruno Miller, Payal Parekh, Shanti Rabindran, and Ines Sousa. The Fellows were chosen on the basis of their academic record, and more importantly, the potential they show to play leadership roles in future environmental debates and discussions. 

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## *2001 Alliance for Global Sustainability annual meeting to be held in Lausanne, Switzerland*

The next Annual Meeting of the Alliance for Global Sustainability will be convened at École Polytechnique Fédérale de Lausanne (EPFL), January 14-17, 2001. The theme for the annual meeting is "Shaping the Future: Tools for Sustainable Development," and the aim of the meeting is to foster a strong interlinkage between science and decision-makers such as politicians and industry CEOs. Four main topics will be approached through plenary and workshop sessions: Managing mega-cities of the future: urban planning and mobility; emerging technologies for the future; food and water for the future; and "a future for the climate": climate and energy. Registration will be held on Sunday, January 14, to be followed in the evening by a buffet dinner and opening speeches by the presidents of the three AGS partner universities, the Swiss Federal Institutes of Technology, the University of Tokyo, and the Massachusetts Institute of Technology. About 300 participants including AGS principal investigators, graduate students from the partner universities, representatives of industry, NGOs and governments, and guests are expected to attend.

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