

## What is the State of the Art in Preparing for Extreme Weather Events?

*Center for Climate Change Law at Columbia University*

*Taipei Economic and Cultural Office in New York*

*Academic Council on the United Nations System*

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### **Welcome Remarks and Introduction of Keynote Speakers**

**AMBASSADOR ANDREW KAO, of the Taipei Economic and Cultural Office in New York,** welcomed the speakers and audience to the event. He conveyed his sympathy to the families who have been affected by Hurricane Sandy and hoped they would be able to return to their normal lives soon. He said his colleagues “and the Taiwanese community will stand together with you to weather the storm and the disaster reconstruction.”

“The connections between Hurricane Sandy and climate change are under scientific scrutiny but we have already learned from New York and all corners of the globe that extreme weather events have become more frequent,” he said. “Extreme weather discriminates against no one and the damages caused by these disasters cannot be confined by political borders or man-made boundaries.” Addressing extreme weather events therefore requires a global mechanism of disaster prevention which must include all nations in a framework of cooperation. “To best prepare for extreme weather events is no doubt a multi-disciplinary and inter-disciplinary effort,” he noted and welcomed the distinguished speakers. “I believe their presentations will help us understand how we can better prepare, from the perspectives of meteorology, law, engineering, and international cooperation.”

**PROFESSOR ALISTAIR EDGAR, Executive Director of the Academic Council on the United Nations System (ACUNS),** began by noting that this was, unfortunately, one of the timeliest seminars co-hosted by ACUNS and the Taiwan Economic and Cultural Office.

Professor Edgar described the mission of ACUNS as an association of academics, non-governmental representatives, and other organizations from all over the world that are interested in the United Nations and in global governance. He noted that ACUNS had recently published its latest newsletter, and he pointed out the symbolic meaning of the iceberg on the cover of the newsletter not only as an icon of climate change and global warming but also as a summary of one of the newsletter articles describing necessary leadership qualities and the fact that 10% are on the surface, but the majority rest beneath the surface.

**PROFESSOR MICHAEL GERRARD, Director of the Center for Climate Change Law at Columbia University,** described his first meeting with officials of the Taipei Economic and Cultural Office as being at a 2011 conference held at Columbia University in conjunction with the Republic of the Marshall Islands on the future of threatened island nations. In August, as the co-sponsors considered potential ideas for a seminar, they discussed the topic of extreme weather events. “Little did we know this would come after the worst extreme weather event New York has seen in generations, and that threatened island nations would refer not only to the Marshall Islands but also Long Island and Manhattan Island.” Although it is too early to know precisely how climate change contributed to Hurricane Sandy, he said, we do know that the global climate models have predicted for years that higher and warmer seas will

intensify extreme weather events. “This is a global phenomenon, and we will hear today from people all around the world on how preparations are being made in their areas.”

“The bad news,” he said, “is that Hurricane Sandy, though an extreme scenario, was not a worst case event.” Hurricane Sandy was only a category 1 storm when it hit New York. The other bad news is that although reductions in greenhouse gases could make a significant difference in the next century, these reductions will not happen quickly enough and will have a time lag such that we will experience the negative effects of climate change in the short term regardless of our mitigation strategy. “The international community must therefore focus on both mitigation and adaptation for the events that will inevitably occur.”

“The good news is that preparations can make a big difference in the damage that will occur,” he noted. This difference is illustrated in the response of the U.S. Federal Emergency Management Agency (FEMA) to Hurricane Katrina, where the response was thought to be lacking, and to Hurricane Sandy, where the response is much improved. “Programs like the one we are having today will help us learn from one another, so I am honored to be participating in this event and I look forward to learning from everyone here.”

### **Keynote Speeches**

**SHAW CHEN LIU, Distinguished Research Fellow and Director of the Research Center for Environmental Changes at the Academia Sinica in the Republic of China (Taiwan)**, discussed the relationship between climate change and extreme weather events and predictions for frequency of future events. “If we just consider the small temperature increase of .6 or .7 degrees and a sea level rise of about 15 centimeters over the past century, I would say I don’t feel very threatened. However, if climate change and extreme weather events are linked, then we should really be worried about climate change,” he said. Examples of extreme weather events include the 2003 heat wave in Europe that killed more than 30,000 people and the 2010 floods in Pakistan that claimed 2000 lives. Droughts are even more damaging in terms of economic and human suffering, Professor Liu noted. Two years ago, the drought in Southeast Asia and nearby southwest China affected tens of millions of people.

As climate change increases global temperature, the probability of high temperatures increases dramatically and record hot temperatures that were not seen in past centuries are now a possibility.

The same relationship exists with precipitation. Professor Liu showed a plot of rain intensity distribution in Taiwan over the past fifty years and showed that the rain intensity shifted towards heavy precipitation. He noted that the 2009 Typhoon Morakot in Taiwan, a level 4 typhoon that killed more than 600 people, buried an entire village in single landslide, and brought down 3,000 millimeters of rain on Taiwan in three days – the equivalent of Taiwan’s total annual average precipitation – was now a much more likely occurrence than under past climate conditions. Fifty years ago the probability of such heavy precipitation was negligible, but due to climate change the probability has increased by more than a factor of three. “Although Morakot could have occurred before, it is much more likely now. If it were a once in a hundred year event, now with global warming it is an every thirty year event,” he said. He also noted that, “If Hurricane Sandy had occurred in Taiwan, most people would have slept through it. The United States, at least in typhoon adaptation, is way behind. I think we can teach you a few things there.”

Although heavy precipitation events will be more likely in the future, the frequency of light and moderate precipitation has decreased due to climate change. “Many people don’t notice this decrease, but light and moderate precipitation is very important for soil moisture and ground water. Therefore, a

continuous long-term decrease in light and moderate precipitation would increase the risk of drought.” The United States, conversely, has seen an increase in precipitation at all levels of intensity due to climate change. “At very light levels we see very little change, and in heavy precipitation we see a change that looks small but is actually a factor of two increase, while moderate precipitation increases in frequency by only 15% or so.” Japan has an even more dramatic increase in heavy precipitation. The heaviest precipitation events have increased in frequency by about 30% over the past century. This means, he said, that “for each degree of global temperature increase we see in the future, we will see a 50% increase in very heavy precipitation frequency.”

When global temperature rises, because the Earth is covered three-fourths by water, the ocean temperature increases, and the saturation of water vapour pressure over the ocean increases, Liu explained. “For each degree increase in water temperature, the water vapour increases by 7% and convection currents like typhoons take in this extra moisture and then the heavy precipitation they create increases by at least that 7%.” In fact, Professor Liu explained, heavy precipitation will increase by more than 7% because the extra moisture in the convection will release latent heat when it converts from vapour to liquid (and at higher altitudes from liquid to solid ice), and that heat will make the convection storm even more violent.

In general, climate models are good at predicting the qualitative change but not quantitative change, so their effect is often underestimated. This was one of the reasons the 2007 IPCC conclusions were so conservative. However, the IPCC did note that we expect heavy precipitation to increase and light precipitation to decrease.

These predictions are especially important for Taiwan as Taiwan is in the path of numerous typhoon tracks. A map plotting typhoons over the past twenty-five years around the globe is almost solid black over Taiwan and Japan, where the islands are completely covered by typhoons. Belize and the Solomon Islands, also represented at today’s panel, are also in storm-heavy areas.

Professor Liu’s research indicates that typhoons will increase in intensity due to climate change. “For every degree increase in global temperature, the precipitation in the worst 1% of events increases by 220%. That is rather scary.” Already over the past century, the top 1% of storms has increased in intensity by a factor of two. “And that factor of two means the floods and landslides associated with these types of heavy precipitation events will increase by a factor of two.” The top 10% of storms have also seen a significant increase in precipitation: 125% increase for every degree of global temperature increase.

These effects are most drastic at the 15N-30N latitude belt where typhoon events increased in frequency by 143% per degree increase in global temperature. In the mid-latitudes this increase drops to 95% and in northern Europe it is only 38% increase for each degree of global temperature increase. “Those who emit the least get hit the worst,” Professor Liu noted. The countries that emit the most greenhouse gases are in the latitudes that see the least significant consequences for rising global temperature. “The emitters don’t get hit much, and the sufferers did not emit anything.”

In Taiwan, the worst 10% events increased 140% in frequency for one degree of global temperature rise. The IPCC 2007 report forecasts an increase in global temperature of 2-4 degrees by the end of the century. “With a two degree increase, multiplied by the numbers we just say, the worst 1% tropical typhoon, that 220% goes up to a 440% increase, and a four degree temperature increase makes it so scary that I don’t like to think about it.” The reality may even be worse than these figures predict. “I am assuming a linear relationship between temperature and typhoon intensity, but my bet is

that it will be more than a linear relationship. So I think it is going to get really bad when we have higher temperatures.” Climate change won’t only affect typhoon intensity. “We can expect floods, landslides, mudslides, droughts, to increase many times – 2, 3, even 4 times greater in the next 20 to 30 years.”

All these predictions mean that adaptation to climate change is an absolute necessity. “In the next ten years, I do not think we will see an effective control on mitigation of greenhouse gases.” Even if an effective mitigation strategy was put in place, the CO<sub>2</sub> already emitted into the atmosphere would continue to affect global climate for roughly 100 years. CO<sub>2</sub> has a half-life of 50 years, so by 2060, if no new emissions are made, half the CO<sub>2</sub> currently in the atmosphere will decay. “So adaptation plans need to aim for at least 2060 and whatever will happen with the climate at that time.” In 2060, Professor Liu estimated, low-latitude flood and mudslide control capacity would need to be increased by a factor of three in order to handle the increased intensity of extreme weather events. Improved water management systems would be required to handle droughts and precipitation events, and “on top of that we need land-use plans to be changed, especially for the mountain areas” in regions such as Taiwan, Philippines, and South and Central America.

**PROFESSOR KLAUS JACOB, Special Research Scientist, Lamont-Doherty Earth Observatory, Columbia University**, visited Taiwan several years before for a workshop on disaster resilient cities and “was amazed how Taiwan lives with disasters, or, I should say, with extreme events and manages to not make them into disasters. It was a very impressive experience.”

“New York City is not devoid of studies,” he said. Over the past ten years, there are a compendium of research projects that have studied New York and climate change. These include two long-term planning studies by the New York Department of Environmental Protection and other City agencies called PlaNYC: smart development plans to accommodate an additional million people in New York City by 2030. The second PlaNYC report includes climate change information and was developed around the same time as a study on the New York City waterfront: Flood-Resilient Waterfront Development in New York City. Professor Jacob focused his presentation on two reports by the New York Panel on Climate Change (NPCC) and the ClimAID study on Responding to Climate Change in New York State, which was inspired by the existence of the New York City efforts to address climate change.

The NPCC report sets out a flexible adaptation pathway to identify climate change adaptation needs and create an adaptation plan. The plan proceeds through eight steps:

1. Identify current and future climate hazards;
2. Conduct inventory of built assets;
3. Characterize the risk of climate change on the built assets;
4. Develop initial adaptation strategies;
5. Identify opportunities for coordination;
6. Link adaption strategies to funding and development cycles;
7. Implement adaptation plans; and
8. Monitor and re-assess the suitability and success of the adaption plans.

New York City began this process in 2010 and is now on step Three, characterizing the risk of climate change on its infrastructure and beginning step four to develop initial strategies. And this, Professor Jacob noted, is where the city was when it was hit by Hurricane Sandy. “Any disaster is an opportunity. Sandy certainly provided lots of policy opportunities. Whether we grasp them or not is another story.”

The ability of New York to adapt to floods will be tested in the future, as rising sea levels and increasingly frequent storm events threaten the city’s infrastructure. The NPCC report found that New

York City temperature would increase by 6 degrees Fahrenheit on average by the 2080s. Increases in annual precipitation would be moderate, and sea level rise predictions depend on whether or not the science takes the potential for rapid melting of the Greenland and Antarctic glaciers into account. “When you take this rapid melting into account, essentially all the sea level rise numbers double. So New York would see four feet of sea level rise by the end of the century. This is extraordinarily consequential as we look at the frequency of floods.”

Sea level rise has significant consequences for the once in one-hundred year storm event, for example. “Let’s assume Hurricane Sandy was a 100 year storm (I don’t think it was). Then right now, this type of flooding will occur once every 100 years; or any given year has a 1% chance of floods. If that is the case, then from sea level rise in a rapid ice scenario, that flood will occur every 1.1 to 3.4 years.” The sea level itself will be so close to the flood level that even small storms will cause massive flooding. “You need only a small event to reach the same flooding levels, and small events occur very frequently, so we will see the level of flooding we saw with Sandy with even small storms.”

“This has not sunk in on our national, global, or city conscience. On a nice, sunny day without wind, the water will be roughly one foot below where Sandy was. And then you add storms on top of that. Or add a Sandy on top of that. That’s what this city and other cities around the world will have to deal with.” By the end of the century, Professor Jacob predicted, “it will be at least an annual event.”

In preparation for such frequent floods, New York City must understand its vulnerabilities and take steps to build resilience. The New York State ClimAID study brought together academics and government agencies in the transportation sector to study the vulnerability of the New York City subway system. The scientists mapped out the Federal Emergency Management Agency (FEMA) 100 year flood event zones and then predicted where those zones would be given a two foot increase and a four foot increase in sea level. The Metropolitan Transit Authority provided information on the location of the entrances, ventilation grates and other access points for flood waters. “It turned out, in 40 minutes, flood waters would go in the subway tunnels, meaning that downtown Manhattan, the Financial District, and all the way up to Canal Street would be severed from Brooklyn. The same situation occurs in Midtown. Uptown Manhattan the tunnels across the Harlem River would be flooded.”

The study also calculated the potential economic effect on the city. It estimated \$10-15 billion in damage to infrastructure plus a 3 to 4 week recovery period for the transportation system during which New York City’s \$4 billion-a-day economy would be operating at less than full capacity. The estimated economic losses of a major flood in New York City were \$60-80 billion, not including all the houses and private property damage that would also be incurred. The actual results of Hurricane Sandy have been less severe. “To my great amazement,” Professor Jacob noted, “the MTA has cut that recovery in half. It is fantastic how fast they have got the subway running again.”

However, in general the New York City transportation system is still very vulnerable. Professor Jacob noted “Of course the question is who will pay for this?” although he also said that money spent on adaptation will prevent lost revenue in the future. “On average, for every \$1 you spend on adaptation or hazard mitigation, you prevent \$4 of losses.” Using this calculation, in order to prevent major damage to New York City transportation, the city would need to spend roughly \$15-20 billion on adaptation measures. Some of those adaptation measures might include:

1. Seal all subway ventilation street grates in current and future flood zones and replace them with a closed ventilation system;

2. Provide flood gates at all subway entrances in flood zones or surround entrances and openings with sufficiently high levees to prevent flood waters from entering the subway tunnels; Professor Jacob called this the “Taipei Solution” because he first noticed its application in Taiwan; or
3. Build a barrier in the harbor.

Professor Jacob expressed doubt about the feasibility and sustainability of a barrier method. New York would need at least three barriers: one between Staten Island and New Jersey, another between Staten Island and Brooklyn, and another between the Bronx and Queens. This would still leave Long Island vulnerable, but other levees or more extensive barrier walls could be built to protect Long Island as well. “I am sort of a barrier skeptic,” he said. “Why? Well, think of New Orleans. It had a defense system. And what happened? The defense wasn’t there when it was needed, so the entire city relied on this one system. I think we are setting ourselves up for the ultimate catastrophe: maybe not in 20 years, but in 100 years, because there is not upper level to sea level rise.” Barriers would need to be extraordinarily large to account for future sea levels, and once put in place they are difficult to raise, so the initial construction would need to account for more than 100 years of sea level rise in order to be a cost effective solution. “Unless we build barriers and take measures that look more than a few decades in advance, we are failing.”

Moving away from flood-prone areas is also an adaptation solution. “Unlike New Orleans, we in New York City can abandon our low lying areas. The Netherlands and Bangladesh do not have that luxury. They are in trouble. We, the world, are in trouble.”

Professor Jacob concluded that adaptation strategies should be based on a cost-benefit analysis that includes future risks and future costs; New York should develop a regional sea level rise adaptation policy and strategy that explores centralized (barrier) methods and de-centralized adaptation methods; and have clear, effective operational interim plans to minimize losses until infrastructure assets can be retrofitted with resiliency efforts. These are technical and engineering solutions, but Professor Jacob also noted that the social and environmental costs of climate change need to be taken into account during adaptation discussions. “It is absolutely amazing to come from New York and see Taiwan. It is a totally different mentality on how a modern state addresses climate change, and Taiwan is a modern state compared to New York because our infrastructure is 100 years old.”

### **Panel Discussion**

**AMBASSADOR COLLIN BECK, Permanent Representative of the Solomon Islands to the United Nations**, emphasized the importance of discussions on climate change and extreme weather events for small island nations that are on the “front line.” Sea level rise and ocean acidification are two of the slow-onset climate change events of the most importance to small island states. “Climate change is not happening in the future. It is happening now. It is a threat multiplier for our nations.” The Solomon Islands are 3-4 meters above sea level, so sea level rise is both a direct threat to the safety of the population and a contributor to higher King Tides and other extreme events. “We have no options,” he said.

Already the Solomon Islands are forced to relocate communities, but these measures are not perfect. Many people who have been moved have been given temporary farmland, but when their claim to that land runs out, they will have to encroach on others’ customary lands. “This has the potential for conflict,” Ambassador Beck noted. “The more drought we see in the islands, the more

people encroach on one another and the more conflict we see.” National disaster councils in the Solomon Islands try to respond to the various disasters, but the national budget is limited and can only address a fraction of the problems.

Climate change threatens the safety and economy of the Solomon Islands. “85% of the population in the Pacific relies on the ocean for food.” Corals that provide critical habitats for local fish populations stop growing at 350 ppm CO<sub>2</sub> in the atmosphere, and global levels have already surpassed this. Coral bleaching and coral death has a significant impact on populations that rely on local fish. “This is for us a daily problem. We see this as everybody’s problem, and the only difference is that some of us are on the front line.”

“Climate change is already irreversible for us. We have arrived at the tipping point. The question for us is how high will the sea rise? How acidic will the ocean become? What are the implications of this? It is going to transform our economy. Those who rely on fish will have to change the investment in that sector because the fishing grounds will shift because of the temperature of the sea.” As an example of how radically this will affect Pacific island states, in Kiribati, 100% of the income depends on fishing. “There is always a human face to these problems. When we speak of extreme weather, we need to see that lives are being affected on a daily basis.” When major cities like New York are affected by climate change, “it will be on CNN” and the challenges the Solomon Islands face every day finally reach other audiences, “those who are not looking at climate change with a sense of urgency.”

“For us, there is only one thing that needs to be done: reduce greenhouse gases. Mitigation, mitigation, mitigation.” But, he said, there is no political will in nations like the United States to change their way of life and contribute to the global solution. For some nations, it is already too late. The Kiribati government is purchasing land from other nations, because “the unthinkable is now looked at as an option.” But, Ambassador Beck noted, “Where does this money come from? It comes from the Kiribati government itself – from the victim.” Instead, he called for global action to this global problem: “This is the one planet we have, so we all need to come together and try to do our bit on mitigation.”

**AMBASSADOR JANINE COYE-FELSON, Deputy Permanent Representative of Belize to the United Nations**, described the often un-noticed frequency of hurricanes in the Caribbean and their damage to the Caribbean economy. She described a hurricane in 1931, during which her grandfather climbed a coconut tree for safety and attempted to save a young woman, but the storm surge washed the young woman away as well as much of her grandfather’s family. Such events are not rare: “Every year we gear up for another hurricane.” Every home receives a map of the damage zones from an insurance company, and every home puts it up on a wall and talks about a preparation plan, “but for many, the plan is just to move to higher ground.”

Extreme weather events threaten the livelihoods of Caribbean states. Massive coral bleaching events over the past two decades have wreaked havoc on local fisheries, the key to the economy. And yet, the effect of hurricanes and climate change on the Caribbean is not well-known outside of the region. Hurricane Sandy hit Jamaica, Haiti, Cuba, Dominican Republic, and the Bahamas. Despite its mitigation and response plans, 4,000 people were affected in Jamaica and the country suffered \$54 million in damages. Sandy was the most devastating hurricane to hit eastern Cuba in the past 50 years: 3 million people were affected and 200,000 homes damaged. Haiti, a nation still recovering from past disasters, received 20 inches of rainfall and 52 people died. The Dominican Republic suffered damage to its agricultural sector totalling \$25 million. And the damage to private property and public infrastructure

in the Bahamas was \$300 million. “This is not small change for our small island countries,” the Ambassador said.

“We have seen an increase in such events, and, according to the IPCC, these events will become more intense and more frequent. Amongst those likely to be especially affected are small islands and coastal areas.” Models from the United Nations Development Program predict “transformational impacts of sea level rise in the Caribbean.” Under a one meter sea level rise scenario, an estimated 100,000 persons would be displaced and many more would be at risk due to storm surge. Limited agricultural lands throughout the region would be lost, and tourism, the most vital sector of the economy, would also be the most vulnerable. One third of the regional airports and tourist resorts are at risk under a one meter sea level rise scenario. The costs of climate change on the economy would escalate significantly towards the end of the century.

“Sea level rise would be nothing short of transformation to Caribbean nations. As a result, we need nothing short of transformational change.” In 2009, regional governments made a special declaration on the impact climate change would have on sustainable development in the region and created a regional framework for resilient development. That framework has five elements and twenty goals to increase resilience and includes elements such as sustainable development, low carbon economy, forests, disaster response, energy efficiency, and marine and coastal systems. In 2012, those same governments established an implementation plan with timeframes, actors, and deliverables.

Ambassador Coye-Felson quoted Belize Prime Minister Dean Barrow in his address to the UNFCCC COP 15:

I wish to point out that it takes no act of genius to recognize either the general global pickle we are in or the particular plight of small island and low lying coastal states. Accordingly the longer term avoidance of adverse climate change effects overall but their immediate amelioration vis-a-vis the most vulnerable must be the measuring stick of success at this conference.

She emphasized the need for global action on climate change. “Our region has taken actions to address the issues. We are engaged in a process to increase resilience and adapt, but we need a global framework with all countries taking on measurable commitments. We need transformational action now.”

**PROFESSOR MICHAEL GERRARD, Director of the Center for Climate Change Law at Columbia University**, described a long history in the United States of disasters helping to spark the enactment of environmental statutes, although this only happens if there is a general sentiment supporting the legislation anyway. The 1967 Torrey Canyon oil spill and the 1969 Santa Barbara oil spill helped to spark the Clean Water Act of 1972. The 1973 crash of a cargo plane at Logan Airport in Boston, a plane loaded with hazardous materials, inspired the Hazardous Material Transportation Act of 1975. The Love Canal disaster of 1978 helped lead to the Superfund Law, and most terribly the 1984 Bhopal, India, explosion of the Union Carbide plant led to the Emergency Planning and Community Right-to-Know Act of 1986. The Exxon Valdez oil spill led to the Oil Pollution Act of 1990, and 1990 also saw major amendments to the Clean Air Act, including Section 112(r) requiring chemical plants to have plans to respond to disasters.

Unfortunately, he said, these two 1990 laws were the last pieces of environmental legislation to be passed in the United States. “Political paralysis since then has disabled the U.S. Congress from playing

a constructive role in addressing emerging environmental problems, so the Administration has been required to work with 30-40 year old laws – to work with the best they have.”

There is a federal statute meant to design the reaction to disasters, the Robert T. Stafford Disaster Relief and Emergency Assistance Act that governs the Federal Emergency Management Agency (FEMA), but as its name implies, the law addresses the immediate reaction to a disaster but few of the preparatory and cautionary actions we have talked about today.

There is no comprehensive or specific law in the United States dealing with adaptation to climate change. “Part of this is because there is a political perception that adaptation is a concession of defeat, a recognition that climate change is going to happen and there is therefore no reason to engage in further mitigation measures. But we now know that we absolutely must do both. We must reduce greenhouse gases and adapt to climate change.”

“The uncertainties surrounding adaptation are so great that it can be difficult to engage. Reducing greenhouse gases at least has a measurable goal and a clear standard -- reduce by this much to see this result. Adaptation is so broad that it is hard to get a handle on, and frankly, some of the projections are so terrible that it is hard to accept them. Earlier during the presentations of Klaus Jacob and Shaw Chen Liu, it was hard not to have a reaction of either despair or disbelief upon hearing the projections. And the danger is that we will have a reaction of paralysis and not do anything.”

Professor Gerrard referenced Rahm Emmanuel’s phrase, “Never let a good crisis go to waste.” He then said, “Now we have the opportunity to see if there is some way that Sandy, having hit the media and financial center of the world, can get the attention of at least this country in a way that will yield the results that we need.”

There are some statutes that could help. First is the National Environmental Policy Act (NEPA) of 1970 that requires environmental impact statements (EIS) to be created before the federal government undertakes any major construction projects. The initial regulations required the preparation of a worst case analysis – what are the plausible worst cases that could be associated with a project and how do you prepare for them. But in 1986 under President Reagan, that provision was narrowed and softened so that this kind of worst case analysis is no longer required and a greater degree of certainty is required before it must be addressed. There is discussion on using NEPA to conduct reverse impact analyses. A conventional analysis is to identify how the project will harm the environment; a reverse impact analysis examines how the environment will affect the project. The legal tools are there to conduct this analysis under NEPA and under state equivalent laws that exist in many states, including New York. But we need to move more aggressively to do this so that when we build infrastructure we are aware of the projections we heard this morning.

There are a handful of guidelines that call for an examination of this sort. A 2009 US Army Corps of Engineers guideline required an analysis of sea level rise for water resource projects conducted by the Corps. The guidelines also require looking at certain studies by the National Research Council about what that sea level rise will be when looking at transportation and other infrastructure. However, these guidelines are not broadly applicable or well-known.

At the international level, the United Nations Development Program (UNDP) has developed a program to promote climate resilient infrastructure. The UNDP Green and Low-emission and Climate Resilient Development Strategies (LECRDS) and associated guidance documents provide advice and guidelines on how to incorporate climate change in building plans. But these are just advisory documents.

The World Bank is a key player in financing climate change projects, and it has developed a number of non-binding guidelines on infrastructure projects so that developers at least think about these type of issues. They have released their own climate screening tool to assist with assessment: Assessment & Design for Adaptation to Climate Change: A Prototype Tool – it is an awkward name, but the acronym is ADAPT. There is a possibility for funding to some projects from this, but there is not nearly enough funding or all the projects that might be eligible.

Two countries have developed systematic methods for dealing with these issues. The first is the Netherlands, which is especially vulnerable to climate change and sea level rise. The Netherlands has a ministry devoted to Infrastructure and the Environment, and within that ministry there is a Directorate-General for Public Works and Water Management – including territorial seas, rivers, navigable waterways, etc. – and policies are implemented by local water boards. There is an additional Directorate-General for sustainable planning as a way of ensuring that the Netherlands incorporates sustainable development. The Netherlands wants to focus on land use before technical fixes. There is also the National Water Assessment Test with mandatory review requirements on construction to see the effects of construction on water ways and water systems. The Netherlands also has a National Adaptation Strategy and they are beginning to develop – which might be the first in the world – a 200 year plan to prepare for a drastically different future. As part of this, they have pledged 1.5 billion Euros to broaden river channels to allow for higher water flows, raised storm gates to protect against surge, and undertaken other projects and are beginning to make projects on what life might look like in the future.

The other country is New Zealand, which in 2004 enacted a law to account for climate impacts on their national highway system. The Transit New Zealand department has a process to evaluate roads to make sure they are prepared for climate change, and for bridges they have updated the design metrics to require climate change to be included in the design. The courts in New Zealand have also taken an active role, and the New Zealand High Court held that climate change should be considered in planning decisions, and this has led to further litigation on how climate change impacts are considered by agencies.

“This is all well ahead of where we are in the United States. We have no comprehensive national strategy. The Department of the Interior has some plans for federally owned lands to address climate change, so there is movement in that direction. But the House of Representatives has tried to halt that, under the theory that climate change is a myth. Legislation passed the House but was thankfully stopped in the Senate that would prohibit the federal government from preparing for climate change.”

“In New York, we face decisions on whether and where we should rebuild. Do we want to spend public money on areas that have been devastated and will be devastated again? These are difficult decisions to make. New Orleans rebuilt the areas that were flooded – they were vulnerable and they continue to be vulnerable. This is movement in the wrong direction. I hope that the terrible event of Hurricane Sandy can be a wake-up call so that serious planning can proceed.”

**PROFESSOR WILLIAM SOLECKI, Director of the City University of New York (CUNY) Institute for Sustainable Cities**, said that the United States needs to learn from the states on the front line of climate change: small island developing states, the arctic, and cities. “These are the areas the globe needs to learn from, and these are the areas where best practices are emerging.” Climate change is expected to hit these regions most severely. “This will not be a fair process,” he said. “We have seen that globally and we have seen that in the New York City region.”

Cities, Professor Solecki said, were particularly important places on the front line of climate change impact. Cities contain massive amounts of infrastructure, large populations, and significant economic power, but they were often built on the water's edge and are therefore vulnerable to sea level rise and storms. "In many situations the impact of climate change can fade into the distance, but at cities the impacts are highlighted."

The process of the onset of climate change, he noted, is not likely to be gradual. It is expected to be punctuated by extreme physical and social changes that will likely create moments of crisis. One shift in the discussion, as the world recognizes the potential threat of climate change, is the idea of resilience and the notion of building a society that is resilient to the climate of today and the future. Building resilience is an expensive venture, but not building resilience also has costs, and "one thing we are quite clear on is that the costs of mitigation, impact, and adaptation will increase over time."

One thing policy makers should not do is rely on technological solutions. Professor Solecki described a movement in geography that praised the "tech fix": "we can solve our way out of environmental problems in many ways, but building higher and better, but we need to think about the suite of opportunities that are available, not only technological solutions but also policy innovations."

As a co-chair of the New York Panel on Climate Change (NPCC), Professor Solecki also spoke about the state of New York City planning and climate change adaptation. He noted that New York had recently codified the existence of the NPCC into law, so that the NPCC now has a statutory mandate to complete recurring assessments on the science of climate change and its impact on the city. One reason NPCC has been so successful is that it has had "buy-in at highest levels," he said. "Mayor Bloomberg has been very forward-looking in the planning and his awareness of environmental issues." The coordination between the scientists on the panel, the New York City Climate Change Task Force, and the city leadership has been a significant factor in the success of the panel.

"All the data indicates that New York flood zones are out of date, and the city is re-drawing those zones. What we see is that with sea level rise, the same storm will place larger chunks of the city under water, and we want to know what to do with that possibility." In response to such threats, New York City is taking adaptation steps, as are cities around the United States. "You see this in the multi-faceted efforts to green New York's infrastructure. The City put \$1.5 billion into projects that will improve storm water management for high precipitation events, the re-development of the water front, and re-evaluation of standards on how the city will adapt to a changing climate."

"Of course, Sandy is a game changer," Professor Solecki said. City Council Speaker Christine Quinn announced her vision for New York's response to climate change, which Professor Solecki saw as a significant political event for the future of New York's adaptation strategy. "Mayor Bloomberg's administration is ending within a year or so, and here is Christine Quinn, one of the favored mayoral candidates very strongly illustrating that Sandy was a game changer and that we have to think about resilience to these events." Looking forward, Solecki said, New York will have to address important questions about the level of risk it is willing to accept, and this "starts to play out in the coastal zone. Is settlement there beyond the risk we accept, and how do we change that settlement pattern given the strong system of property rights in the U.S.?"

**JUSTIN HARRIS, Program Manager at the Office of International and Tribal Affairs, U.S. Environmental Protection Agency (EPA)**, described the important partnership between the United States and Taiwan that has developed over the past twenty years and continues to inspire further regional coordination. The U.S. EPA and the Taiwan Environmental Protection Agency have a long-

standing partnership to address numerous issues, including greenhouse gas reduction, remediation and land use, clean air and water regulations, enhanced legal compliance, and waste management. 2013 marks the 20<sup>th</sup> anniversary of this partnership.

The U.S. and Taiwan recognize that environmental issues have a cross-boundary affect that involves many nations. Pollution from China travels to the United States and contaminates our food and our air. "Eating fish is why most of us have mercury in our bloodstreams," he said, as an illustration. Vulnerable populations such as children and the elderly are particularly susceptible to the harms of this pollution.

Moving forward, the U.S. – Taiwan partnership will continue to address these issues but also expand into a regional effort. "Addressing regional challenges on a bilateral basis is not sufficient," Harris said. Instead, he described a two-pronged approach in which regional agencies identify shared priorities and explore possible ways to leverage partnerships to address those challenges. The U.S.-Taiwan relationship has "created a platform in the Asia-Pacific region for discussion on technical issues" including clean-up of polluted sites, sustainable communities, reducing mercury, sustainable ports, and management of electronic waste. "Agencies throughout the region see the U.S.-Taiwan partnership as a resource and a platform."

"The most important lesson from Sandy was that there is real urgency in this work."

### **Question and Answer**

During the question and answer period, Ambassadors Coye-Fehlon and Beck discussed their expectations for the upcoming UNFCCC discussions in Doha and other possible strategies for encouraging global movement against climate change. Ambassador Beck said the four goals in Doha for Small Island Developing States were to 1) ensure a second mitigation commitment to follow the Kyoto Protocol, 2) to increase the ambition level of the mitigation discussions, 3) to implement a financial mechanism to address resilience, and 4) to ensure financial and technology transfer mechanisms are finally implemented to allow nations affected by climate change to respond. Beyond the Doha negotiations, Ambassador Coye-Fehlon acknowledged that there is an effort in the General Assembly to request an opinion from the International Court of Justice, but described this approach as "thinking outside the box." As to Doha, she said that the power of SIDS had been reduced by the "multiplicity of issues on the agenda and the multiplicity of groups" involved in the negotiations, but she said they still maintain a strong position based on "moral leverage" and will need to "keep internal focus within the group" in order to succeed in the negotiations.

One audience member mentioned that moving New York communities is really "deconstructing" those communities, to which Ambassador Coye-Fehlon noted, "In terms of relocation, we are talking about deconstructing countries. This is magnified." She later added, "We have managed to create frameworks at the international government level, but we haven't been able to recognize on a people-to-people level that we share the same challenges and threats from climate change."