Summary of Science Diplomacy 2015[1]

Scientific Drivers for Diplomacy

April 29, 2015

A conference hosted by the Center for Science Diplomacy of the American Association for the Advancement of Science (AAAS) in Washington, DC, USA.

About the Conference

The emergence of science diplomacy as an active area of study and policy consideration has increased its use and users. The role of large-scale research infrastructures in science diplomacy and the mechanisms for scientific cooperation needed in undertaking science diplomacy are examples of important topics to address in order to bridge the scientific and foreign policy communities. At the same time, different scientific disciplines have unique contributions to and needs from diplomacy as their international efforts become more intertwined with those of the foreign policy and diplomatic communities. The AAAS Center for Science Diplomacy hosted a one-day conference that critically addressed the scientific drivers for diplomacy. Sessions, organized by experts,[2] focused on the following themes: diplomacy needs and impact of the earth and environmental sciences, health and biomedical sciences, and physical sciences; cross-cutting areas of transboundary issues and shared scientific resources; the role of institutions and networks; and scientific cooperation during political strain.

Plenary

The conference was opened by Rush Holt, CEO of AAAS,[3] and Flavia Schlegel, assistant director-general for natural sciences of UNESCO. They spoke of the important role that science-based institutions, such as AAAS and UNESCO, play in twenty-first century diplomacy.

Holt stressed the evolution of science diplomacy as a concept in the United States from a focus on the support for diplomacy to more broadly emphasize the support also for science. U.S. science for diplomacy grew from track II diplomacy efforts during the Cold War to the development of new

[1] For conference videos and materials, please visit http://www.aaas.org/page/science-diplomacy-2015-scientific-drivers-diplomacy-resources. The conference was supported in part by generous grants, through the AAAS Center for Science Diplomacy, from the Golden Family Foundation and the Richard Lounsbery Foundation.

[2] Program steering committee: Vaughan Turekian (chair), AAAS; Paul Berkman, University of California, Santa Barbara, and University of Cambridge; Cathleen Campbell, CRDF Global; E. William Colglazier, AAAS; Gary Machlis, Clemson University and U.S. National Park Service; Jason Rao, American Society for Microbiology; and Tom Wang, AAAS.

[3] Rush Holt, "Scientific Drivers for Diplomacy," *Science & Diplomacy* 4, no. 2 (2015), http://www.sciencediplomacy.org/perspective/2015/scientific-drivers-for-diplomacy.

partnerships with the Middle East in the post-9/11 era. In the twenty-first century, science becomes even more critical in complex international negotiations on issues such as nuclear nonproliferation and climate change. Scientific advancement also needs broader international cooperation. For countries to collaborate to address global challenges such as climate change, infectious disease, and antibiotic resistance, the governance of cross-border activities needs to make it easier for scientists to cooperate (e.g., transporting materials, specimens, and equipment) despite challenging political relationships. Broader cooperation also depends on the partnerships to help build capacity in developing countries to absorb and advance science. Such globalization of science ultimately means bringing scientists from across the globe and development spectrum into international policy discussions.

Schlegel connected science diplomacy and science governance. UNESCO has a seventy-year history of promoting international science and education cooperation that was formed explicitly to cross boundaries, including political divides of nations, following World War II. Its international initiatives have overcome East-to-West and North-to-South divides to advance science, including large research facilities and scientific institutions such as CERN, Synchrotron-light for Experimental Science and Applications in the Middle East (SESAME), the International Centre for Theoretical Physics, and The World Academy of Science (TWAS), and to address global challenges, including using water diplomacy to address transboundary water management and helping manage transnational biosphere reserves. To ensure success of international initiatives like these, UNESCO has emphasized taking a multi-government approach with global governance that includes all the stakeholders. UNESCO and the European Commission will be launching a new initiative on the science of science diplomacy to improve the management of diverse stakeholders in global science governance.

Theme Sessions

Sessions focused on six specific themes that either focused on specific disciplinary areas or on cross-cutting issues. The main points from each session are highlighted below.

Earth and Environmental Sciences

- Global cooperation is necessary to confront global environmental issues (e.g., biodiversity loss, aquatic dead zones, etc.); even many public health issues, such as water-borne diseases (e.g., cholera), are also linked to environmental and climatic variables.
- Scientific information is needed to address transboundary environmental issues and global environmental planning.
- Mutual respect, good communication, and cultural relevance and sensitivity are all vital to effective science diplomacy. This is true between countries, but also when working with American Indian tribes, in which the unique history, culture, and power structure of each tribe must be considered.

Biology and Health

- There are many opportunities for science diplomacy in biology and health, including opportunities that may seem more obvious (e.g., countering the spread of drug-resistant TB) and those that may seem less obvious (e.g., the rise of gastroenterological ailments such as inflammatory bowel disease (IBD); mental illness and depression).
- Drug-resistant TB is a global problem and addressing it will require building international partnerships for monitoring, diagnosis, exchanging samples and expertise, capacity building, and drug development.
- Science diplomacy between the United States and China on IBD has become possible because of the recent increase in IBD cases in China; recent changes in the healthcare system in China, including the formation of medical societies; and the presence of willing partners and funders on both sides.
- Mental health and depression are international issues that remain difficult because of stigma, lack of effective treatments, and lack of access to mental health professionals.
- Scientific societies play a central role in science diplomacy, science policy, and science advocacy. They are a useful mechanism for bringing scientists together across borders and for educating policymakers with accurate information. Thus, scientists should get more involved with their scientific societies.

Physics

- Physics research requires significant funding, equipment, and expertise that can only be met on an international scale. Scientific discovery and research knows no borders or conflict.
- Governance models are key to the success of any international collaboration and require effective and credible leadership.
- Examples such as SESAME, CERN, and the Atacama Large Millimeter Array are all models for effective scientific discovery and diplomacy.

Transboundary and Shared Resources

- Seventy percent of Earth lies within international spaces.
- The Arctic is an important test case for new international mechanisms that can balance national interests with common interests for the benefit of the world.
- Data diplomacy offers a new diplomatic tool for fostering relationships through data sharing and cooperation and it is needed to address issues such as hacking and leaks.
- International laws are necessary to address multiple issues related to the oceans—such as food security, biodiversity, and carbon storage.
- Decision making for international fisheries management must be based on the best available science.

Institutions and Networks

- TWAS, the Malta Conferences Foundation, and the Inter-American Institute for Global Change Research (IAI), are examples of important nongovernmental and inter-government mechanisms for enabling science diplomacy.
- Science collaboration needs to connect East and West, North and South, and within the South.
- Institutions and mechanisms are needed to catalyze regional collaboration around common problems and supporting education, coordinate networking efforts, and reach across science diplomacy practitioners and theoreticians.

Cooperation During Political Strain

- It is important to support open communication with project partners and build trust.
- Institutional commitment is necessary to keep the relationship strong.
- Long-term success is based off mutual honesty and respect.
- It is important not to overlook a "moral agenda" for collaborative work.
- Capacity building is key to ensure future generations are able to carry on these endeavors.

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Appendices

Appendix A: Theme Session Summary
Earth and Environmental Sciences

Rapporteur:
Teresa Stoepler, AAAS S&T Policy Fellow, U.S. Geological Survey

Summary of Chair Introduction:
Gary Machlis
Professor of Environmental Sustainability, Clemson University
Science Advisor to the Director of the National Park Service

Machlis briefly introduced the session and the speakers, noting that the field of earth and environmental sciences encompasses a wide array of challenges and institutions. He explained that the session would not attempt to be exhaustive in this field, but each speaker would bring his or her unique insight to the topic.

Summary of Speaker One:
Rita Colwell
Distinguished University Professor of Cell Biology and Molecular Genetics, University of Maryland

"Climate, Infectious Disease and Human Health in an Era of Climate Change"

Colwell focused on the diplomacy of water and water-borne disease issues, using cholera in Haiti and Bangladesh as case studies. Colwell explained that there are 1.5 billion cases of cholera per year, causing two million deaths globally. Cholera outbreaks are linked to environmental and climatic variables such as precipitation, flooding, and phytoplankton abundance. The causal agent of cholera, the bacterium *Vibrio cholerae*, is a natural inhabitant of rivers, ponds, and coastal waters. *Vibrio cholerae* attaches to copepod hosts, dominant components of zooplankton, which primarily consume phytoplankton; thus, zooplankton and phytoplankton populations are closely linked. Phytoplankton blooms occur with increased temperature and sunlight, leading to greater zooplankton populations and increased cholera incidence. Seasonal coastal plankton blooms cause "endemic cholera" outbreaks every spring and fall. Using satellite data, phytoplankton can be measured as chlorophyll content and monitored as an environmental indicator of cholera risk.

Colwell and her colleagues have demonstrated that increases in sea surface temperature in the Indian Ocean over the past forty years have resulted in increases in phytoplankton and a concomitant rise in cholera cases in Bangladesh. They have also developed highly accurate predictive models for Calcutta and Bangladesh showing that a mere 1 mm increase in rainfall per day leads to a 7 percent increase in the number of cholera cases. Colwell has demonstrated that the combination of severe rain, above average air temperature, and an event that creates high population density (e.g., an earthquake, a festival) create the prime conditions for a cholera outbreak. Based on historical weather data from 1823 to 1948, Haiti experienced both the most severe rainfall and the hottest

summer in sixty years in 2010. These conditions, coupled with the devastating earthquake, led to the cholera epidemic.

Colwell, Anwar Huq, and colleagues hypothesized that a simple water filtration procedure could reduce cholera incidence by removing phytoplankton from drinking water. Through an NIH-funded study in Bangladesh, they found that a sari cloth folded four times creates a filter of 10 to 20 micrometers, which is large enough to trap phytoplankton and the copepods carrying *V. cholerae*. This simple filtering technique resulted in an initial 50 percent decrease in cholera incidence. To reach out to the community and reinforce the need to filter water, they enlisted a public health extension agent. When the research team returned five years later, 75 percent of the local villages had adopted filtering, resulting in a synergistic "herd immunity" effect. In conclusion, Colwell emphasized that if we could provide safe drinking water and proper sanitation worldwide, twenty-six diseases (for which only two currently have vaccines) would be eliminated or reduced.

Summary of Speaker Two:
Thomas Lovejoy
Professor of Environmental Science and Policy, George Mason University
Biodiversity Chair, Heinz Center for Science, Economics and the Environment

Lovejoy described four cases where science and diplomacy intertwine: (1) Diplomacy can enable science. (2) Science gives us important information about the environment. (3) The challenge that we are "exceeding our planetary boundaries" to support life on Earth. (4) Understanding how people think through social science research findings.

First, diplomacy can enable science. For example, the Organization for Economic Cooperation and Development (OECD) Megascience projects catalyzed the creation of the Global Biodiversity Information Facility (GBIF) in 2001. The GBIF is an international, open system of linked biodiversity databases of the world's 1.5 million named species. This harnessing of diplomacy within the OECD context has made an important contribution to environmental planning worldwide.

Second, science tells us important things about the environment that can be translated for diplomacy and decision making. For example, by analyzing oxygen isotope ratios in rainwater, Brazilian scientists showed that half of the rainfall in the Amazon rain forest is internally generated. The discovery that vegetation can influence climate directly raises the question, "at what point will deforestation cause the hydrologic cycle to unravel?" The Amazon is already 20 percent deforested and has had two historic droughts. To confront this transboundary issue, we need integrated planning and management among the eight Amazon countries such as the Amazon Cooperation Treaty. Currently, more than 50 percent of the Amazon is now under some form of protection.

Third, we have exceeded our "planetary boundaries," or the biological limits that nurture human existence, in sometimes dangerous ways. Confronting global environmental issues such as biodiversity loss, the increasing amount of nitrogen in the atmosphere, the increase in aquatic dead zones, and climate change will require science diplomacy. A significant proportion of CO_2 emissions

come from the destruction of modern ecosystems. If we do eco-restoration at scale, we could avoid an approximately ½ degree average C global temperature increase. The 2^0C target average global increase is probably too high for most biological systems, so reducing that increase is critical.

Finally, understanding human behavior and how people think is critical to managing our systems and this will require social science research.

Summary of Speaker Three:
Robert Megginson
Deputy Director, Mathematical Sciences Research Institute, University of Michigan

"Science Diplomacy with U.S. Indigenous Peoples"

Megginson stressed that when working with tribes it is critical to understand their unique historical context and emphasis on oral tradition and memory. Scientists must understand that the "trail of broken treaties" is the historical context within which any science diplomacy with Indian tribes will occur. Most of these treaties required Indians to surrender land, while providing education and healthcare.

Megginson outlined the "Prime Directive" of science diplomacy with tribes: be scrupulous in keeping the promised timeframe; remember that all science on Indian land is necessarily a partnership; keep in mind that tribal entities are not just another regional government authority because of the greater regional sense of ownership held by tribes; seek partners, but be realistic about what they can contribute (without dismissing those with resource-based, informal training); appreciate that each reservation has unique cultural and historical differences and tribal power structures; and finally, respect native religions, spirituality, and cultural imperatives. Megginson further recommended that researchers read the "Bali Principles of Climate Justice" (2002) before doing scientific research on tribal lands and follow its guidance.

Megginson outlined one success and one failure as case studies of science diplomacy with tribes. The Navajo Nation Math Circle Project (NNMCP), which was launched by Tatiana Shubin, a professor of mathematics at San Jose State University, is an example of successful tribal diplomacy. The goal of the NNMCP is to develop and demonstrate the math circle concept in the Native American community in order to attract more Native Americans into STEM fields, specifically the field of mathematics. The NNMCP includes three major components: after school programs at a number of schools on the reservation, teacher development programs, and a two-week summer program. The program is co-directed by Shubin, Henry Fowler (Diné College), and David Auckly (Kansas State University). The NNMCP has trained nine hundred students and many teachers. As a result of her leadership in directing the NNMCP, Shubin was adopted into the Navajo Nation, something that Megginson noted was almost unprecedented. In contrast, Megginson cited the Alberta Tar Sands Project and what it has done to the people and land as an example of failed science diplomacy with tribes.

Megginson concluded by warning researchers not to use examples of American Indian support to leverage broader community support for treaties and agreements. As a historical example, Charles Curtis, called "Indian Charley" because he was half Kaw and Osage Indian, was trusted by the American Indian community because of his Indian descent, until the Curtis Allotment Act (1898) broke up the reservations in Oklahoma, allowing expanded white settlement into former Indian lands.

Highlights of Discussions/Q&A's:

Audience questions for Colwell focused on how her team collaborated with the Haitians on the ground in response to the cholera epidemic following the earthquake and what advice she had for scientists dealing with politically sensitive issues (e.g., the controversy surrounding the origin of the cholera in the Haiti epidemic). Colwell said that her team used scientist-to-scientist connections to complete their research in Haiti, just as "we scientists have been doing all our careers." She said the source of the cholera in Haiti was a complicated issue, but local (Haitian) strains are implicated, and the most important factors are the interplay between climate change and severe weather. She also highlighted the need to consider satellite sensing as a public health tool to preempt outbreaks (e.g., satellites can identify dust storms, which can indicate meningitis outbreak risk).

Lovejoy was asked to provide an example of an "inspiring, bold leap forward" in biodiversity conservation and diplomacy. He described the expansion of Costa Rica's national park system as such an example. Costa Rica had only three parks when the government collaborated with the Nature Conservancy and the World Wildlife Foundation to create Corcovado National Park. This was catalytic in the formation of subsequent parks, aided by Costa Rica's tradition of prioritizing education and their openness to foreign scientific collaboration.

Megginson was asked about the best way to collect and share data when working with tribes and how his principles can be applied to all international collaborations. Megginson recommended working with federated tribes on open data issues so that the scientist is dealing with a single entity, and emphasized the need for good two-way communication, a clear agreement, and a mechanism to monitor the implementation of the agreement on both sides. He agreed that the principles he outlined, which are based on mutual respect, should be applied to all scientific collaborations, but that their unique history makes working with tribes different.

Appendix B: Theme Session Summary
Biology and Health

Rapporteur:
Nicholas J. Anthis, AAAS S&T Policy Fellow, USAID

Summary/Highlights of Chair Introduction:
Jason Rao
Director of International Affairs, American Society for Microbiology

Rao provided a brief introduction to our panel and to the use of science diplomacy in health and biology. He noted that the subject matter of the panel would span from topics that would be more obvious to discuss in terms of science diplomacy (e.g., emerging infectious disease) to those that would be less obvious (e.g., gastroenterology). He noted that when we lead with science in diplomacy, we are more likely to make friends and allies. Rao also introduced the audience to *Cultures*, a free quarterly publication from the American Society for Microbiology, which covers the intersection between science policy and global challenges. He serves as its editor-in-chief.

Summary/Highlights of Speaker One:
Gail Cassell
Executive Vice President of TB Drug Development, Infectious Disease Research Institute
Visiting Professor of Global Health and Social Medicine, Harvard Medical School

"Global Crisis of Drug Resistant TB: Challenges and Opportunities in Science Diplomacy"

The overall themes of Cassell's presentation were that drug-resistant tuberculosis (TB) is a global problem and that addressing it will require international collaboration and cooperation. She first presented a brief introduction to TB and its drug resistance, followed by a description of various science diplomacy initiatives with which she has been involved in order to counteract it. Two particularly striking facts are that two billion people worldwide are infected with TB and two million people die from TB every year. Drug-resistant TB comes in different varieties based on severity: multidrug resistant (MDRTB; resistant to isoniazid and rifampicin), extensively drug resistant (XDRTB), and totally drug resistant (TDRTB). Highlighting the difficulty of the work ahead, Cassell said that the successful treatment of XDRTB will require three to four new classes of antibiotics simultaneously, which is an enormous technical and financial challenge, considering that it normally takes at least ten years to develop a single new drug.

Cassell highlighted a few important and/or underappreciated areas of TB work where science diplomacy should play a role. She said that the magnitude of the MDRTB problem has historically been grossly underestimated, thus much of the important work from her perspective is in improving the reporting of MDRTB. Pediatric drug-resistant TB is also an area that has historically been underappreciated, so in response, the international Sentinel Project was launched in 2011. Its goal is to end child deaths from drug-resistant TB by launching joint projects to raise visibility, share best practices, and monitor gaps in knowledge. Lastly, Cassell argued that work on point-of-care diagnostics should be given the highest priority. She highlighted earlier work that changed the dogma

in the field by showing that MDRTB/XDRTB is easily transmitted person to person (as opposed to the idea that someone with TB just acquires drug resistance over time). Diagnosis is a major problem because most high-burden countries currently have less than one laboratory per ten million people. Thus, it will be important to be able to diagnose TB at the point of care, rather than depending on laboratory infrastructure that does not exist.

Cassell spoke about several international collaborative efforts that have been launched to target drug-resistant TB. One of these is the Lilly Philanthropic MDRTB Partnership, which focuses on transfer of technology, healthcare provider training, assistance to governments to design MDRTB strategies, and surveillance of MDRTB. Cassell chaired the Forum on Drug Discovery, Development, and Translation, which was created in 2005 by the Institute of Medicine as a multiyear initiative. In 2011, the TBResist Consortium was formed by the CDC, the Lilly Foundation, the National Institute of Allergy and Infectious Diseases, and the Broad Institute of MIT and Harvard. It includes many institutional members from across the globe, and two global meetings have been held so far. As part of this initiative, the NIH Fogarty International Center was given permission to work with two partners in Iran, which was important because the first case of TDRTB was discovered in Iran. The initiative includes three sequencing centers: the Broad Institute, the Chinese CDC, and the Russian Academy of Sciences. Cassell spoke about the importance of engaging particular parts of the world on drug-resistant TB, and she believes that the BRICS (Brazil, Russia, India, China, and South Africa) countries should take the lead on developing new treatments. The second BRICS health ministers' meeting was held in 2011 and resulted in the Delhi Communiqué, in which the participants resolved to collaborate on capacity and infrastructure, drug development, clinical trials, and access to treatments.

Summary/Highlights of Speaker Two:
Valery Danilenko
Head of Department of Post-Genomic Biotechnology, Vavilov Institute of General Genetics, Russian Academy of Sciences
Dmitry Maslov (speaking)
Research Associate, Vavilov Institute of General Genetics, Russian Academy of Sciences

"Mycobacterium Tuberculosis 'Hybrid Warfare': Virulence, Pathogenicity, Persistence and Drug Resistance"

Maslov gave a presentation about a specific example of an international consortium that is working together to fight TB. He noted that TB has the potential to unite researchers around the world. Maslov gave an introduction to TB, including the facts that TB is the leading cause of death of HIV/AIDS patients and that a third of the world's population is infected with TB. He noted that the problem is even worse in Russia, where the fall of the Soviet Union and its healthcare system has enhanced the spread of TB, and now 20 percent of new cases and 50 percent of re-treated cases are MDRTB. Maslov also gave an introduction into the biology and the mechanisms of TB drug resistance.
TB involves multiple global challenges, which Maslov divided into fundamental challenges (understanding mechanisms of drug resistance and developing novel anti-TB drugs) and

epidemiological challenges (analyzing epidemiological patterns and preventing spread). To counter some of these challenges, the TBResist Consortium was formed as a joint international effort to combine the differing technological capacities of different institutions and nations involved in order to collect and analyze new data on TB. Within Russia, five different institutions are involved, each brining different expertise. Specific activities of the consortium include unifying clinical and laboratory methods, exchanging samples and expertise, putting on workshops, performing whole-genome sequencing and compiling genetic and proteomic databases, performing functional analyses of genes and mutations, evaluating the cross-border spread of TB strains, and setting up international laboratories.

Summary/Highlights of Speaker Three:
John Allen
President, American Gastroenterological Association
Clinical Chief of Digestive Diseases and Professor of Medicine, Yale University School of Medicine

"Scientific Drivers for Diplomacy: The China Syndrome"

Allen gave a presentation about inflammatory bowel disease (IBD) and the particular opportunity that its recent rise in Asia presents for scientific diplomacy. Scientifically, the recent increase in IBD cases in China presents a unique opportunity to better understand the fundamental etiology of IBD—an opportunity that was missed when IBD rose to prominence in the United States in the 1950s and Japan in the 1970s. As part of his talk, Allen provided a brief overview of the basic pathology of IBD and some details of the inflammation process in general. He also discussed how the recent rise of IBD in China is challenging the current understanding of the condition developed from past studies on predominately white populations.

During his talk, Allen stressed the importance of medical societies, especially in China. In 2014, the American Gastroenterological Association (AGA) and the Chinese Society of Gastroenterology signed a three-year memorandum of understanding on building scientific partnerships. He described how a confluence of factors has come together to make international science diplomacy around IBD possible. One of these factors is the ongoing work of the AGA in terms of supporting international science, holding meetings, supporting young investigators, and launching the Center for Gut Microbiome Research & Education. Another factor making an IBD partnership possible is the various changes that have occurred in China in recent years. These include changes in its healthcare system—such as improvements in hospital governance and staff—and in general societal factors—such as the rise of the middle and upper classes. Of particular importance is the rise of medical societies in China, which means that the AGA now has an organization to partner with, something it lacked before. The medical system in China has gone through many changes over the years (Allen described four phases), and only within the last five years have they had the ability to conduct clinical trials there. The final factor that makes IBD a viable science diplomacy issue is that there is funding available from pharmaceutical and medical device companies as well as philanthropic organizations in the United States and in China, and organizations in the United States are interested in setting up cooperative agreements.

Summary/Highlights of Speaker Four:
Mark Rasenick
Distinguished Professor, University of Illinois at Chicago

"Global Mental Health: A Growing Problem and a Downward Spiral"

Rasenick gave a presentation about depression as a major public health problem with growing international dimensions. He began with some stark facts about depression and suicide, including that suicides occur about three times as frequently as homicides and that by 2020 the World Health Organization predicts that depression will be the primary cause of disability. Less than one half of people who are depressed are diagnosed, and it is estimated that depression has an annual cost in the United States of about $500 billion, including loss of productivity. Major factors contributing to this problem are that stigma discourages many from seeking treatment, most depression therapies require six to twelve weeks before improvement of symptoms, the field has been content with settling for response rather than recovery, and pharmaceutical companies are only designing new drugs based on existing drugs. Rasenick believes that the solutions to these problems are approaching depression as a neurobiology issue, better understanding the molecular basis of depression, and identifying clear and easily obtainable biochemical and genetic markers for diagnosis and treatment.

As depression and mental illness become a growing problem in the developing world, there are unique challenges that emerge, and these will require novel approaches. For example, the prevalence of psychiatrists in the general population is 1:10,000 in Western Europe, but it is 1:400,000 in Central Africa. However, there are many faith healers there, and the psychiatry community should engage with them. Rasenick believes that more funding—including private funding—will be central to solving the problem, as long as it is done correctly. He pointed to the example of HIV/AIDS as an area where "throwing money at the problem" really was key. However, funding bodies are not as interested in mental health, as they prefer more tangible problems. Cultural competence will be important going forward, and it may be possible to take advantage of unique features in different locations. He pointed to the use of family involvement in Cuba, for example.

Highlights of Discussions/Q&A's:

An ongoing theme on the panel and in the Q&A was the role of scientific societies in science diplomacy. Rao noted that the role of scientific societies has changed as the publication landscape has shifted and as meetings have become more virtual. Cassell emphasized that scientific societies play a vital role by spreading sound science so that good policies can be implemented. She also said that societies have a bystander mentality, making them reluctant to engage with policy makers, and she argued that this should change. This led to a broader discussion about the interaction between scientists and policy makers. Allen noted that AGA is the oldest medical society and that it is very engaged with policy and even has its own PAC—a feature that is apparently more common with medical societies than scientific societies. He said that a larger percentage of physicians give to PACs,

but only 3 percent of researchers do; the researchers are more reluctant for some reason. He argued that scientists should get more involved in policy. Rasenick postulated that scientists think that getting involved in policy means going to the Hill and begging for money. However, Cassell disputed this, saying that at the American Society for Microbiology, they see their role primarily as educating. Rasenick noted that there is always a need for "loaners" on the Hill (people from other government agencies who spend time in Congress to provide scientific perspectives), offering another way scientists could be involved in policy. Rao also suggested the AAAS Science & Technology Policy Fellowship. Overall, though, Rao said that the take-away message from all of this is that advocacy is important and scientists should get involved with their scientific societies.

There was a question about whether it is more difficult for scientists from other countries to publish, particularly in public health. Maslov said that it is difficult to publish in the TB field in general. For some scientists outside of the United States there is also an issue with access to translators. Rasenick argued that we need to rethink our dependence on impact factors. On the flipside, he noted that a great aspect of science today is that because of online catalogues, we come across work that we never would have previously.

There was discussion about the particular difficulty presented by mental health issues. Cassell posed the question: you can cure all of these diseases, but what about the mental side? How do you train a healthcare workforce to deal with mental health issues? In response to another question about whether it would be possible to create a global Internet platform to address mental health, Rasenick suggested that it could be interesting to look at providing some sort of rudimentary psychotherapy in silico.

Cassell made the point that in these discussions, someone needs to define exactly what "science diplomacy" actually means, because in infectious disease, this is just what they do normally. She said that the smallpox eradication program is a great example of science diplomacy, as is the polio vaccination program, though it is still in progress.

Appendix C: Theme Session Summary
Physics

Rapporteur:
Jennifer Roderick, AAAS

Summary of Chair Introduction:
E. William Colglazier
Visiting Senior Scholar, AAAS

Colglazier focused on the macro scale challenges, strategies, and importance of science diplomacy around the world. With specific focus given to the physical sciences, the chair discussed how diplomacy can often remove obstacles that traditional methods of international relations cannot. In order to achieve success, however, strategy and coordination of efforts is key and often exceptionally difficult to achieve. Nevertheless, the importance of science diplomacy cannot be understated nor can the requirement for the United States to maintain the lead within the physical sciences. It is for these reasons that governments around the world must understand how they can both facilitate and encourage such opportunities for the benefit of scientific discovery and mankind.

Summary of Speaker One:
Amy Flatten
Director of International Affairs, American Physical Society

"Scientific Drivers for Diplomacy: American Physical Society - International Physics Programs"

Flatten built on the foundations presented by the chair by introducing specific examples of drivers in the physical science sub-disciplines and the opportunities, strategies, and challenges involved with them.

As an international membership organization, the American Physical Society (APS) engages internationally through a number of cross-cutting programs that can be classified under the four key drivers: Fostering Communication; Capacity Building; Developing Global Scientists; and Shared Scientific Resources. Here are some examples of the programs that were discussed:

- SESAME (The Synchrotron-Light for Experimental Science and Applications in the Middle East is a regional cooperative scientific activity involving the construction and utilization of a synchrotron light source. This activity, which is taking place in the Middle East despite political tensions, is supported by a global partnership of seven major scientific societies.)
- Entrepreneurship Workshops, Travel Grants, and Exchange Programs
- APS March and April Meetings and Roundtable events

Of the four strategic drivers presented, Shared Scientific Resources underpins the remaining three in the physical sciences. Since physics is global, the resources to achieve scientific discovery are also required to be global given that they are significantly expensive and complex to produce. It is due to this that in the physical sciences countries can often not "go it alone" and thus individual activities often provide models for international partnerships.

While the application of each program presented varied, the strategic goals and objectives remained common: the promotion of economic growth and development, and hence in the long-term, economic and political stability and sustainability around the world. Most significantly, in order to achieve these goals, scientific diplomacy must involve action and not just discussion.

Summary of Speaker Two:
Esen Ercan Alp
Senior Scientist, Argonne National Laboratory

"Modern Photon Sources: Shining Examples of Scientific and Diplomatic Cooperation"

Alp focused the conversation down to the level of the individual scientist and presented a number of examples of scientific and diplomatic cooperation in the area of modern photon sources.

From the earliest discoveries within the physical sciences, competition has existed. The quest to be better than one's counterparts was often the driving force behind many nations, and institutions desire to be the first with regards to equipment, intellectual property, and discovery. Over time, however, it has been realized that within scientific competition there can be more than one winner providing there is effective and credible leadership within collaborations. Modern photon sources provide a practical example of such international and multi-disciplinary collaborations, of which several were presented during the session.

As a case study for which Alp has been significantly involved, SESAME (previously introduced by the first speaker), is an example of how international scientific collaborations can prevail regardless of competition. SESAME diplomacy, as Alp presented, is a model for how nations with known political differences, tensions, and priorities can come together to produce the Middle East's first operational synchrotron.

First supported by UNESCO in 2002, it has taken SESAME twelve years to produce its first light. Nevertheless, while scientific achievements are only just beginning, diplomatic and strategic achievements have been significant over the past decade. SESAME's success is due to a number of factors including the credibility and effective leadership of UNESCO and council presidents from existing synchrotron collaborations (e.g., CERN); international scrutiny of all scientific and technical aspects; the inclusion of international organizations and observer nations; and determined leadership from the host nation, Jordan. While such successes cannot and should not be understated, many issues continue to remain unresolved. Such issues, including the U.S. financial contribution, Iranian sanctions, and the security situation in the Middle East, must therefore continue to be addressed before they are allowed to impede on scientific discovery and development within the region.

Summary of Speaker Three:
Ethan Schreier
President and CEO, Associated Universities Inc.
Adjunct Professor of Physics and Astronomy, Johns Hopkins University

"Science Diplomacy 2015: The Perspective from Astronomy"

Schreier presented the perspective from a traditionally international endeavor and collaborative science, astronomy. Astronomy crosses borders and is inherently large, requiring large facilities, large budgets, large international collaborations, and various governance mechanisms. It is for these reasons, among others, that astronomy is detailed as the leader in international collaborative science.

Pursuing astronomical discoveries requires large, expensive, remotely located facilities that are often internationally funded, managed, and manned and increasingly partnered with public–private partnerships. As a key strategic driver, economics drives astronomers to collaborate. Various examples of collaborations were presented including a specific case study on radio astronomy and ALMA (Atacama Large Millimeter Array), the next major international collaboration. ALMA, a billion dollar project completed in 2014, is a merger of three independently conceived projects from Europe, North America, Japan, and Taiwan.

While the science diplomacy drivers in astronomy are clear, implementation of collaborations are often exceptionally difficult requiring a variety of differing governance models depending on the nations and institutions participating. A number of governance models with examples were presented including ALMA, which given the equal participation of nations has led to an unstable equilibrium "made to work by hard work and goodwill."

As the leader in international collaborative science, many lessons can be learned from astronomy. Lessons include appreciation of cultural factors; cost of coordination; the adequacy of formal agreements; host nation considerations; the requirement for flexibility in governance models; and the requirement to preserve the preeminence of scientific considerations.

Summary of Speaker Four:
Patricia McBride
Senior Scientist and Head of Particle Physics Division, Fermilab

"International Collaboration Particle Physics"

McBride presented the particle physics perspective of science diplomacy by opening with a quote from the Strategic Plan for U.S. Particle Physics in the Global Context, "Pursue the most important opportunities wherever they are, and host unique, world-class facilities that engage the global scientific community."

As with astronomy, particle physics has a long history of international collaboration given the ever-increasing demand for larger and more expensive equipment and expertise. Patricia presented the historical context and development of international partnerships in particle physics leading up to the CERN Large Hadron Collider, which is the achievement of nearly one hundred countries and ten thousand scientists from around the world. CERN also has a unique model of governance, based on

the separation of the governance of infrastructure and experiments and this was described in detail in the session.

The success of CERN and costs associated with nations individually embarking on independent research have resulted in national strategic plans being created around the world in a global context. The Deep Underground Neutrino Experiment was presented as an example of how for the first time in its history the United States will host a large-scale science facility that is international from the start based on the same governance models as CERN.

As we move to an era of big projects with big costs it is necessary to share design, implementation, and operation across borders. This requires significant balance between national needs, interests, and expertise and global scientific objectives.

Highlights of Discussions/Q&A's:

A significant number of questions were presented during the session building on the presentations provided by the speakers and chair. From these questions significant themes became apparent including the issue of funding, governance, national versus international interests, physics as a model for other scientific disciplines, cultural differences, and how to connect scientists and technical offices to policy makers both domestically and internationally.

Appendix D: Theme Session
Transboundary and Shared Resources

Rapporteur:
Noël M. Bakhtian, AAAS S&T Policy Fellow, DOE

Summary of Chair Introduction:
Paul Berkman
Research Professor, Bren School of Environmental Science and Policy, University of California, Santa Barbara
Head, Arctic Ocean Geopolitics Program, Scott Polar Research Institute, University of Cambridge

Thirty percent of Earth lies within the boundaries of nations—these areas are governed by national interest. Seventy percent of Earth lies within international spaces—these areas are governed by common interest. "Science diplomacy is an international, interdisciplinary, and inclusive process to balance national interest and common interest for the benefit of all on Earth," Berkman said. The Arctic is a test case for this balancing act. Other common interest areas include the high seas, Antarctica, deep sea, and outer space.

Topics covered include (1) science as an instrument for Earth system monitoring and assessment or even as an essential gauge of changes over time and space, (2) science as an early warning system, (3) science as a determinant of public policy agendas and an element of international institutions, (4) science as a source of invention and commercial enterprise, (5) science as an element of continuity in our global society built on an evolving foundation of prior knowledge, (6) science as one of the "subsidiary means for determination of rules of law," as provided by the International Court of Justice, and (7) science as a tool of diplomacy, fostering open dialogues to protect our common welfare and the world we live in.

Summary of Speaker One:
Timothy Dye
Professor of Obstetrics and Gynecology, Pediatrics, Public Health Sciences, and Medical Informatics, University of Rochester School of Medicine

"Data Diplomacy"

"Data diplomacy is an emerging construct that integrates concepts from data science, technology, and computing with social science, international relations, and diplomatic negotiation, and in some cases, offers a new diplomatic tool that facilitates global (and local) relationships." Data diplomacy isn't a new idea: a *Science* article from 1978 discusses new computer networks and data crossing international boundaries and the "digital divide." However "big data" is a new, transformative phenomena. Consider that in 2000, 25 percent of the world's stored data was digital, whereas that number is now about 98 percent.

Examples of data-based acts with diplomatic implications including (1) sharing of and cooperating on data, (2) "ransomware," (3) big data hacking, and (4) big data leaks. Data diplomacy considerations

include cultural perspectives, perception, trust, complex data content, expectation of transparency, and a rapidly changing technological landscape.

Summary of Speaker Two:
Kristina Gjerde
Adjunct Professor, Middlebury Institute of International Studies at Monterey

"International Spaces: Challenges of Managing Marine Areas Beyond National Jurisdiction"

"Science diplomacy—in all its forms—is vital to sustainably managing our shared global ocean." First, marine biodiversity is of common concern. All the oceans on Earth are connected. The high seas allow for food security and biodiversity, and they are a major carbon storehouse. Issues of concern include climate change, ocean acidification, and interactions. Second, the UN Convention on the Law of the Sea (UNCLOS) provides for cooperation but needs updating. An interesting aspect of UNCLOS is that freedoms are actually linked to obligations. For example, freedom to fish, navigate, lay submarine cables, conduct marine scientific research, etc., is linked to the obligation to protect/preserve marine environment, cooperate, comply with the convention and other rules of international law, conserve marine living resources, etc. Third, science diplomacy has already played a significant role in raising awareness and informing decision making. Finally, the UN has launched a process to develop a legally binding construct under UNCLOS, which means that "science diplomacy is even more important." This breakthrough occurred in January, 2015, with the UN agreeing to develop a legally binding instrument for conservation and sustainability.

Challenges and opportunities for science diplomacy in this space include (1) informing decision making (a common shared understanding for what's at stake, applying existing scientific information management, and ensuring that scientific advisory processes stay non-politicized), (2) facilitating international science collaboration, and (3) using science cooperation to improve international relations between countries (i.e., bringing countries such as Russia and Cuba to the table.)

Summary of Speaker Three:
David Balton
Deputy Assistant Secretary for Oceans and Fisheries, U.S. Department of State

"Preparing for Future Arctic Fisheries: How Science Informs Policy"

Arctic fisheries are complex, with some managed by Arctic countries, some jointly managed, and some not managed at all. There are some areas that have been covered with ice for all of human history, until now. Currently, there are areas with no fish worth catching, but with warming and changing ecosystems, a northern migration that can sustain commercial fishing seems likely. Russia, Canada, Denmark, Norway, and Russia are major players in the area, as are China, the EU, Iceland, Japan, and Korea—countries that do commercial fishing far from home.

The concern is that there isn't enough science yet to determine what levels of fishing are sustainable. For this reason, the United States prohibits commercial fisheries in the Arctic Management Area (north area of Alaska), but this jurisdiction ends at two hundred miles offshore. The United States is hoping to extend this rule to other Arctic areas and implement an international mechanism for managing Arctic fisheries.

Appendix E: Theme Session Summary
Institutions and Networks

Rapporteur:
Rhema Bjorkland, AAAS S&T Policy Fellow, EPA

Summary of Chair Introduction:
Marga Gual Soler
Project Director, Center for Science Diplomacy, AAAS

Before introducing the panel, Gual Soler opened the session by noting that the various scientific disciplines could not drive science diplomacy without the institutions and networks that provide the umbrella for such activity. Gual Soler also commented on the growth in the number of sectors that have a stake in science diplomacy efforts; these now include government, private sector, and nongovernmental organizations. She noted that establishing these international connections are fundamental for managing shared resources and transboundary issues.

Summary of Speaker One:
Romain Murenzi
Executive Director, The World Academy of Sciences (TWAS)

"A View from the South: Science Diplomacy in the Developing World"

Murenzi talked about the U.S. shift in policy to China, begun under President Richard Nixon, as an example of the transformative power of science diplomacy; the U.S.-China decision to engage in science diplomacy resulted in greater stability and prosperity. Today, 275,000 Chinese students attend American universities and U.S.-China trade has increased from US$2 billion then to US$594 billion in 2014. The work of the International Center for Theoretical Physics (ICTP) provides an even earlier example of the bridging of the East-to-West and North-to-South divide. Founded in Trieste, Italy, the ICTP was the vision of Pakistani and Italian physicists. The ICTP provided a rare line of communication between scientists from the East and West, and later, it emerged as a focal point of cooperation between the North and South.

Abdus Salam, one of the founders of the ICTP, later started the Third World Academy of Sciences (now The World Academy of Sciences). Since then, connections among less developed nations have grown; South-to-South collaborations have increased as several countries have made enormous strides in higher education teaching and research capacity and also because of the higher costs of studying in the more developed countries. Despite these advances, Murenzi observed that there is a significant gap in science diplomacy, and the general trend in dialogue and collaboration in scientific endeavors between the developed and developing countries has continued to widen. Murenzi noted lack of access to the Internet represents a significant digital divide that must be bridged if this trend is to be reversed. Although scientists in the developing world engage in international collaboration, not many are familiar with science diplomacy. Addressing this absence of active science diplomacy requires building partnerships that are mutually beneficial. Key ingredients of productive partnerships include balanced and fair interactions, respect, independence among the collaborating institutions, cooperation in capacity-building endeavors, and sharing of benefits. Murenzi stressed that science

diplomacy is critical for advancing international cooperation on critical regional and global issues such as climate change, ocean health, and education. Building science diplomacy would enhance within-country capacity to advise governments and diplomats and it would promote the growth of external networks and international connections.

The World Academy of Sciences (TWAS) is bridging this gap with science diplomacy issues in South-to-North leadership dialogue and education and training. The leadership dialogues bring together scientists and policy makers. For example, Science and Diplomacy: Central Europe and Southern Mediterranean and the Italy-Africa Day are recent leadership dialogue events organized by TWAS. In the areas of education and training, TWAS conducts lectures and workshops on energy and transboundary issues and summer courses that bring scientists and diplomats together. Murenzi also recognized the work of other organizations involved in science diplomacy, including the InterAcademy Panel, a global network of science academies and the InterAcademy Medical Panel, the association of medical academies and medical sections of science academies. In his closing remarks, Murenzi emphasized that science diplomacy cannot solve every problem, and to fully harness the power of science diplomacy will require an understanding and acknowledgement of the differences in historical perspectives and needs between regions and countries.

Summary of Speaker Two:
Zafra Margolin Lerman
President, Malta Conferences Foundation

"*Science Diplomacy: Cross-border Collaborations towards a Sustainable Future*"

Lerman began her comments by describing the origin and purpose of the Malta Conferences. Six conferences have been held since 2003 and a seventh will be held later this year in Rabat, Morocco. She spoke of the philosophy underpinning the conferences: equal access to education is a right that belongs to all. The conferences provide a forum where scientists from Middle Eastern countries, whose governments are often hostile to one another, can explore what unites rather than what separates and where regional problems that require cooperative action can be discussed. A cornerstone of the Malta Conferences is the assumption that establishing personal connections can reduce the politically induced background and bias of the "us and them" tension and the attendant hostility.

More than five hundred scientists from fifteen states have now participated in the Malta Conferences, and the number of early career scientists, graduate students, and women attending the conferences continues to grow. In addition to the opportunity for participants to interact with invited Nobel Prize laureates, the Malta Conference format includes workshops in focus areas selected by the participants: energy, environment, and water quality; science and technology education; chemistry and biomedical chemistry; analytical nanotechnology and material science; chemistry safety and security; and entrepreneurship and innovation.

Lerman identified the need for a unified curriculum in science education and suggested it would reduce the region's lag in science and advance efforts in science diplomacy. Her comments echoed a call by the participants to have the latest theories and developments in science and technology education integrated into Middle Eastern curricula. Two recommendations stemming from these conferences were a call for the development of the Centers of Excellence that would facilitate short-term exchanges by faculty and students and a Middle Eastern virtual campus. Using examples, Lerman demonstrated how the Malta Conferences have catalyzed regional collaboration with the creation of the Middle East Air and Water Quality Forum. Some initiatives include online courses, a working group on Drinking Water Quality Assessment in the Middle East, and a Transboundary Partnership (involving Israel, the Palestinian Authority, and Jordan). Participants of one of the Malta Conferences unanimously adopted a resolution calling on world governments to address the critical shortage of clean drinking water in the Gaza Strip.

Lerman closed by noting that science is the bridge between conflict and peace.

Summary of Speaker Three:
Maria Uhle
Program Director for International Activities, Directorate of Geosciences, National Science Foundation
Chair, Inter-American Institute for Global Change Research (IAI) Executive Council

"Science Diplomacy through the Lens of Intergovernmental Institutions Examples from the Inter-American Institute for Global Change Research (IAI)"

Uhle began by stating that her talk would be about science diplomacy from the perspective of intergovernmental institutions, with specific reference to the IAI. Envisaged as an intergovernmental instrument that would bring scientists and policy makers together, the IAI focuses on the development of the capacity to understand past, present, and future global change in the environment of the Americas. The IAI provides a platform for the pursuit of common goals and the bridging of political and developmental differences to tackle shared challenges. The U.S. Global Change Research program that began under President Ronald Reagan became a Presidential Initiative under President George H.W. Bush; regional engagement led to the Montevideo Agreement of 1992, which established the IAI.

Specifically, the IAI's goals are to promote collaborative, well-informed actions and to ensure science excellence. This work emphasizes building collaboration among researchers, stakeholders, and decision makers and the principle of co-design of research programs. The structure of the IAI has evolved over time. Currently, it operates with geographically distributed centers (directorates) operating below the Scientific Advisory Committee, Science-Policy Advisory Committee, and Executive Council. This organizational format allows countries with particular capacities and strengths to lead: Brazil (Science Development), Argentina (Science-Policy Liaison), and Uruguay (Integrated Operations and Finance). Programmatic activities of the IAI are carried out under four banners:

collaborative research networks, a small grant program, capacity building activities, and work with international conventions.

The IAI's collaborative research on land use in tropical dry forests has been used to clarify points of law, presenting complex scientific issues such as ecosystem function and biodiversity in the case before the Brazilian judicial system. This facilitated the establishment of criteria for protected areas in Brazil, based on informed decision making. The IAI small grants program has supported water science and policy in Chile, Argentina, and Bolivia to address the feedback between the environment, land use, and the hydrological cycle and policy decisions.

In closing, Uhle noted that moving toward science diplomacy requires a coalition of those willing to work on common problems through the joint development of research activity. Complex challenges require a systems approach and, inevitably, trade-offs. The skills needed to master international scientific collaboration are not typically covered in general scientific training. It is important to have conditions that promote dialogue and begin building coalitions early in the careers of scientific experts.

Highlights of Discussions/Q&A's:

1. <u>The Role of the Internet in Their Work in Building Consensus and Achieving Transparency</u>
   Uhle said that because the IAI's directorates are dispersed, the organization uses teleconferencing, Skype, and social media, with limited face to face meetings to minimize costs. The IAI established and developed its Science-Policy Advisory Committee solely through remote communication means.
   Lerman: In the Middle East, maintaining connections is very difficult, especially in conflict zones (e.g., Syria). Email connection is sometimes unpredictable. Skype has been instrumental. Nevertheless, communication can be difficult and slow.

   Murenzi said that TWAS maintains regional offices. He noted that, given the fact that TWAS members are national academies around the world, technology, including smart phone technology, was important in communication and that Internet access was essential. He noted that he committed time to building relationship with members and supporters of TWAS with Internet resources.

2. <u>The Brain Drain from the South and the Relationship with the Diaspora</u>
   Murenzi noted that someone has to first invest in higher education before you can have a "brain drain" and that the policy and politics in some countries are key determinants in the movement of educated and talented citizens out of those countries. The lack of free speech, support, and other conditions are important issues. Governments and societies need to foster the conditions to retain their educated populace, including their scientists. The development of the scientific capacities of countries in the South may have an impact in keeping scientists in their home countries or the wider region. He also called for more

opportunities for short-term international exchanges between scientists as a mechanism that might significantly impact retention of scientists in their home countries.

3. Training and Providing Experience in Science Diplomacy

   Lerman said that she believed that this process and training, when it happens, starts earlier in many countries than in the United States. She has had experience collaborating with professional scientific societies here in the United States to bring international scientists to the United States and noted that there may be more barriers to U.S. nationals because of language issues (English being a more common denominator for most non-U.S. students and scientists). She noted that there are large international populations studying in some of the wealthier Middle Eastern states. She also noted that American students are generally encouraged to study abroad. The expansion of overseas campuses of U.S. universities would enhance opportunities for U.S. students

   Uhle said that the National Science Foundation (NSF) is very cognizant of this issue. Students are encouraged to learn and be exposed to research activity and institutions internationally. The NSF has certain programs that require international collaboration

4. Supporting Networks of Networks

   Uhle said that the IAI is a network of networks. Young scientists should be a key focus in building international collaboration. She noted that programs such as Future Earth are designed to provide support for young scientist networking. NSF is working on mechanisms to support network coordination.

   Lerman said that greater support is needed for coordination of networking efforts. She supports the call for more intergenerational engagement such as the Boomer-Millennial wisdom bridge mentioned by a member of the audience. She also noted that the American Chemical Society is making strides in this area.

   Murenzi said that five young affiliates are elected by TWAS each year. TWAS supports them as they represent a network of alums.

   Gual Soler remarked that there are two networks of young Latin American scientists, who are energetic, but need support.

5. The Role of Science Diplomacy in Crisis Areas/ Regions

   Lerman said that the Malta Conference Foundation is careful in selecting participants and being sensitive to their individual circumstances. In international science diplomacy engagement, neutral venues and umbrellas are very important. Finally, when nations are in conflict with each other, governments have to be convinced that it is important to send their scientists to participate.

Appendix F: Theme Session Summary
Cooperation During Political Strain

Rapporteur:
Cristine Geers, AAAS

Summary of Chair Introduction:
Frances Colón
Acting Science Adviser to the Secretary, U.S. Department of State

Colón emphasized the continued importance and need for countries with both positive and sometimes strained foreign relations to collaborate across borders on issues of common interest—including public health, food security, climate change, biodiversity, and energy, among others.

In many cases, it is possible to present national and global solutions to these common challenges by promoting scientific exchanges, opening research, and broadening our networks. In cases where diplomatic channels are not totally open, it is critical to focus on key challenges and projects that rise above political strains as a first step in opening dialogue. This is seemingly the intersection where science diplomacy begins.

Summary of Speaker One:
James Hammond
Research Fellow, Imperial College London

"Mt Paektu Geoscientific Experiment"

Hammond presented an interesting example of cooperation during strained foreign relations in the case of his Mount Paektu Geoscientific Experiment, a project supported by numerous international partners focused on studying the volcanological and seismic data from the North Korean side of the Mount Paektu volcano, which borders China. Volcanic activity has the potential to disrupt international air traffic, dislocate mass populations, and change the overall climate. This was a particularly interesting project to work on as volcanoes are transboundary threats that are often poorly understood because of their remote locations. Hammond pointed out that, in this case, both the North Korean and Chinese governments need information gathered and analyzed on Mount Paektu—creating an opportunity for foreign scientists to begin this collaborative project.

The timing of transboundary threats do not always align or co-sync with political relationships and foreign policy; in this case, the increase in the number of earthquakes, volcano deformation, and volcanic gases all point to a recharge of Mount Paektu. This was the spark of Hammond's project and the beginning of his work in North Korea. As the collaboration has continued to grow, a group of Western scientists were invited to North Korea and more recently a group traveled from North Korea to England for meetings and cultural activities. Secondly, Hammond discussed a similar relationship-building process with his work in Eritrea, and the 2011 eruption of the Nabro volcano. This is another example of how the persistence of international partners, successful communication channels, and good local partners can help establish scientific partnerships and collaborations where formal political relations are strained.

Summary of Speaker Two:
Gary Machlis
Professor of Environmental Sustainability, Clemson University
Science Advisor to the Director of the National Park Service

Machlis highlighted several aspects of "tensive science" in cases where there are tensions and/or strained relations among political parties domestically, between local and national missions, between the public and scientists, and between cooperative adversaries. He also noted cases where scientific cooperation happens with the "enemy." (He gave the example of Operation Paperclip where the OSS brought former Nazi scientists out of Germany and relocated and integrated them into American society.)

In cases where it is necessary to conduct science in a time of crisis, Machlis highlighted the importance of focusing on the mission and not the process itself. This was furthermore described in terms of the uncertainty that comes in these tense situations. Here, communication is key. One must be able to not only perform tasks under duress or pressure, but also translate scientific information and data into immediate policy recommendations, understand metrics and scalability, and, finally, communicate science with the public or "non-scientists" with what he calls "speaking truth to power." Machlis also highlighted a number of proposals for working in "tensive science": first, one must research best practices and invest in future scientific methods; second, organizations and governments must invest in pre-crisis protocols; third, we must understand the nature of "back channels" and keep those partnerships healthy and open; fourth, a new generation of skilled science diplomats are needed; and fifth, there should be an international forum for scientific cooperation during times of crisis where experts can convene via a third party remotely.

Summary of Speaker Three:
Sergio Pastrana
Foreign Secretary, Cuban Academy of Sciences

Pastrana offered insight and highlighted many of the strong historical accomplishments made since the creation of the Cuban Academy of Sciences in 1861. Prior to the creation of the academy, the majority of investments made into Cuba were highly focused on agriculture and thus limited scientific development within the country. Over the years, and even amid strained foreign relations with the United States, both countries have profited from an increase in the number of scientific exchanges between the biotechnology and biomedical scientific communities. Pastrana noted that over the course of the last two decades alone, a number of workshops have been designed and implemented for young scientists within the United States, and in 2002, a presentation was made with AAAS in Boston on the status of science in Cuba that highlighted some of the most important areas of scientific research within Cuba—agriculture, renewable energy, biotechnology, and medicine in the tropics.

Pastrana concluded his presentation by considering what future challenges academies of science around the world will face. He noted the importance of institutions and governments to recognize excellence within their staff and work, to continue to promote science and scientific collaborations, to preserve history and heritage, and to encourage international and transboundary activities.

Highlights of Discussions/Q&A's:

Questions raised during the Q&A session all seemed to bring the group back to the basics of scientific cooperation and the power of both relationships and relationship building. While it is of utmost importance that the science behind many of the abovementioned projects is solid and strong, these collaborations would not be possible without strong relationships with in-country partners. These partnerships require open lines of communication that allow individuals to work together through various political regime changes with honesty and openness. In order to achieve this, researchers and scientists must remember to be patient and convincing in order to gain domestic support for these various projects.

Appendix G: Agenda
Science Diplomacy 2015: Scientific Drivers for Diplomacy

8:00	**Registration and Breakfast**
9:00	**Plenary**
	Rush Holt, CEO of AAAS **Flavia Schlegel**, Assistant Director-General of UNESCO
10:00	**Break**
10:30	**Theme Sessions**
	Earth and Environmental Sciences Chair – **Gary Machlis**, Clemson University and U.S. National Park Service **Rita Colwell**, University of Maryland **Thomas Lovejoy**, George Mason University **Robert Megginson**, University of Michigan
	Bio and Health Chair – **Jason Rao**, American Society for Microbiology **John Allen**, Yale University **Gail Cassell**, IDRI and Harvard University **Valery N. Danilenko**, Vavilov Institute of General Genetics **Dmitry Maslov**, Vavilov Institute of General Genetics **Mark Rasenick**, University of Illinois at Chicago
	Physics Chair – **E. William Colglazier**, AAAS **E. Ercan Alp**, Argonne National Laboratory **Amy Flatten**, American Physical Society **Patricia McBride**, Fermilab **Ethan Schreier**, Associated Universities, Inc. and Johns Hopkins University
12:30	**Lunch**

2:00	**Theme Sessions**
	<u>Transboundary and Shared Resources</u> Chair – **Paul Berkman**, University of California, Santa Barbara, and University of Cambridge **David Balton**, U.S. Department of State **Timothy Dye**, University of Rochester **Kristina Gjerde**, Middlebury Institute of International Studies at Monterey
	<u>Institutions and Networks</u> Chair – **Marga Gual Soler**, AAAS **Zafra Lerman**, Malta Conferences Foundation **Romain Murenzi**, The World Academy of Sciences **Maria Uhle**, National Science Foundation
	<u>Cooperation During Political Strain</u> Chair – **Frances Colón**, U.S. Department of State **James Hammond**, Imperial College London **Gary Machlis**, Clemson University and U.S. National Park Service **Sergio Pastrana**, Academy of Sciences of Cuba
4:00	**Break**
4:30	**Wrap-up Plenary**