**Science and Technology for Development: Where We Have Been, Where We Are Now, and Where We Need To Go** (draft, Oct. 21, 2020) E. William Colglazier

When Victor Rabinowitch departed for the MacArthur Foundation in 1990, his legacy to the National Academy of Sciences (NAS) and National Research Council was a vibrant Office of International Affairs (OIA). Encompassing committees covering all aspects of international issues, OIA was an instrument for marshaling scientific expertise and knowledge to make the world a better place.

Studies, workshops, and international scientific engagements overseen by OIA were carried out by the Committee on Scholarly Communication with China (with an office in Beijing), the Committee on Japan, the Committee on International Organizations and Programs, the Committee on Human Rights, the Office of Central Europe and Eurasia, the Committee on International Security and Arms Control, and the Board on Science and Technology for International Development (BOSTID). OIA also staffed dialogues between the NAS leadership and the leadership of other scientific academies, including the Royal Society, the Soviet/Russian Academy of Sciences, and the Chinese Academy of Sciences.

As OIA's largest unit, BOSTID focused on international scientific engagement with lower and middle income countries. The purpose was to build their scientific capabilities and to help them to improve the lives and livelihoods of their people. Among the programs was a large effort funded by USAID to select through peer review research projects addressing development topics carried out by scientists in these countries.

The wide variety of BOSTID studies is illustrated by this selection from the 1980s and 1990s: Lost Crops of Africa (1996), Sustainable Agriculture in the Humid Tropics (1993), Vetiver Grass: A Thin Green Line Against Erosion (1993), Conserving Biodiversity: A Research Agenda for Development Agencies (1992), Micro-livestock: Little-Known Small Animals with a Promising Future (1991), Toward Sustainability: Soil and Water Research Priorities for Developing Countries (1991), Saline Agriculture: Salt-Tolerant Plants for Developing Countries (1990), Lost Crops of the Incas (1989), U.S. Policy for the 1990s: Science and Technology for Sustainable Development (1989), Science and Technology Information Services and Systems in Africa (1989), Fisheries Technologies for Developing Countries (1988), U.S. Capacity to Address Tropical Infectious Disease Problems (1987), Workshop on Biotechnology in Agriculture (1986), Opportunities in Marine Science and Technology for Developing Countries (1985), Workshop on Thai-U.S. Science and Technology Collaboration (1984), Amaranth: Modern Prospects for an Ancient Crop (1984), Crocodiles as a Resource for the Tropics (1983), Panel Discussions on Science and Technology Planning and Forecasting for Indonesia: Special Emphasis on Manpower Development (1983).(1)

During Victor Rabinowitch's tenure, BOSTID became a major resource for programs, studies, dialogues, and engagement in science and technology (S&T) for development. BOSTID continued its work after he left OIA. It was an important part of his legacy contributing to how S&T can be marshaled to advance prosperity, security, and peace throughout the world.

<u>A Personal Perspective on Science and Technology for Development</u>

The progress achieved by applying S&T for development over the past thirty years has been significant. Important initiatives undertaken by U.S. institutions and the United Nations have helped to make a difference. Many developing countries are today able partners in international scientific and technological cooperation. Yet much remains to be done, and the COVID pandemic and other global challenges are significant problems. With increasing international cooperation and harnessing new

pathways for progress created by advances in science and technology, the potential exists for an even brighter future for the developing world.

This article represents my personal perspective on "where we have been, where we are now, and where we need to go" on S&T for development. I was fortunate to inherit Vic's legacy at the National Academies when I became executive director of OIA from 1991 to 1994. My interest in the issues of S&T for development continued throughout the next seventeen years at the National Academies as well as when I worked at the State Department and advised at the UN.

My interest started even earlier when I was an AAAS S&T Policy Fellow for Representative George E. Brown in 1975-76 and when I worked under Paul Doty at the Center for Science and International Affairs at Harvard University and at the Program on Science, Technology, and Humanism at the Aspen Institute from 1978-1983. This article begins with an initiative from that era, and then provides vignettes from subsequent years when I learned more about S&T for development. These stories illustrate for me important aspects of the evolution in how best to advance low and middle income countries using expertise and engagement in science and technology. The stories are quite limited since they come from an American perspective heavily influenced by experiences at the U.S. National Academies, the State Department, and at the UN. The intent is to illustrate broader issues and lessons that I believe are still relevant today. The concluding section addresses the impact of the pandemic and what needs be done going forward.

Institute for Scientific and Technological Cooperation (ISTC)

In March of 1978 President Carter proposed creation of a new government agency focused on the role of science and technology in development. Emphasizing cooperation between the U.S. and the Third World, the agency was intended to foster research, strengthen indigenous capabilities, and facilitate scientific and technological cooperation. It would have much in common with the International Development Research Center (IDRC) in Canada including, like IDRC, sponsoring research in developing countries led by nationals in those countries. The Institute for Scientific and Technological Cooperation (ISTC) became the name of the proposed government agency.

With the ISTC and USAID, the U.S. would have had two development agencies like Canada. The ISTC would support training and research on key development and global problems including regional institutions such as the Agricultural Research Centers. It would provide mechanisms for collaborative projects in science and technology between American and foreign institutions, including participation by middle-tier developing countries.

Paul Doty and I helped to organize a conference in Aspen in 1978 to discuss a blueprint for the ISTC, which included its planners, Congressional staff, members of the U.S. scientific and technical community, and scientists from developing nations.(2) In 1979 the ISTC was authorized by Congress. However, funding was not appropriated due to opposition in the Senate.

Some of the opposition came from those who felt two agencies would be duplicative and divert resources from addressing basic human needs of the poor. Some of the negative voices even came from USAID. There was also concern about aiding other countries in industrialization. The 1980 House-Senate Appropriations Conference Committee approved $12 million to USAID for programs similar to those envisioned in the ISTC. In the 1980s a somewhat larger portion of USAID's funding was directed to programs involving science and technology, and BOSTID was one of the beneficiaries.

In 1991 the new Administrator of USAID, Brian Atwood, wrote an oped during the drafting of the Clinton administration's report on foreign assistance reform. He emphasized four strategic objectives: the environment, population and health, economic growth, and democracy and stated: "our nation must reassert its leadership in the field of sustainable development."(3) He did not mention the role of science and technology.

Joint Projects and Studies by the National Academies Relevant for Developing Countries

The OIA strategic plan in the 1990s emphasized joint projects and studies with developing countries addressing key issues of importance to both countries. An additional goal was to strengthen the ability of our foreign partners to be influential, independent advisers to their governments on public policy issues and decisions where inputs from science and technology are needed. The model was that of the U.S. National Academies. The hope was that stronger science advisory ecosystems would help lead to wiser decisions. It was also felt that the domestic science and technology community in a country was more likely to influence its government than advice from foreigners. This approach may seem naively idealistic for the hard realities of government decision-making in much of the world, but it has influenced the international activities of the U.S. National Academies ever since.

One of the largest efforts in the 1990s was carrying out a project for the Government of Indonesia funded by a World Bank loan. OIA had several staff and an office in Jakarta. The focus was strengthening indigenous S&T institutions, including universities and national labs, to be more effective in working with and contributing to the productive sector of the Indonesian economy. The purpose was to assist the private sector including with applications of high technology. The project had an objective to improve peer review in awarding research projects and advancing scientific personnel. It also included the longer term goal of creating a science funding institution in Indonesia like the U.S. National Science Foundation. The Indonesians did benefit from the joint effort, and a cohort of bright young Indonesians were trained. However, more may have be learned by the Americans regarding the challenges of strengthening scientific institutions in developing countries.

The National Academies carried out many studies addressing issues relevant to developing countries during the 1990s and early 2000s. The committees were composed primarily of American experts. Some studies were carried out jointly with scientific institutions in specific countries, including with China and in the Middle East. Among the studies and activities carried out during this period were: Marshaling Technology for Development (1995), Meeting the Challenges of Megacities in the Developing World (1996), America's Vital Interest in Global Health (1997), Control of Cardiovascular Diseases in Developing Countries (1998), The Pervasive Role of Science, Technology, and Health in Foreign Policy (1999), Our Common Journey: A Transition Toward Sustainability (1999), Water for the Future: The West Bank and Gaza, Israel, and Jordan (1999), Cooperation in the Energy Futures of China and the United States (2000), Transgenic Plants and World Agriculture (2000), The Future of Personal Transport in China (2001), Growing Populations, Changing Landscapes: Studies from India, China, and the United States (2001), Personal Cars and China (2003), Cities Transformed: Demographic Change and Its Implications in the Developing World (2003), Urbanization, Energy, Air Pollution in China: The Challenges Ahead (2004), Learning from SARS: Preparing for the Next Disease Outbreak (2004), The Role of Science in Solving the Earths's Emerging Water Problems (2005), and Lost Crops of Africa: Vegetables (2006). The studies related to China and the Middle East were in collaboration with scientific academies and other institutions in those countries. Also during this period, NAS President Bruce Alberts chaired a committee

for the World Bank reviewing the CGIAR agricultural research institutes and making recommendations on how to strengthen them.

InterAcademy Panel, InterAcademy Council, and the ASADI Program

Representatives of national academies from around the world met in New Delhi in October 1993 in a Science Summit on World Population. The outcome was a statement signed by 58 academies aimed at the UN International Conference on Population and Development in 1994.(4) The recommendations addressed: (i) key determinants of population growth; (ii) resource consumption, the environment, and quality of life on a finite earth; (iii) human reproductive health; (iv) sustainability of the natural world as everyone's responsibility; (v) what S&T can do to enhance the human prospect; and (vi) the need for action now.

The New Delhi conference stimulated the creation of the InterAcademy Panel in 1993. Its focus was on building capacity, capabilities, and influence of science academies across the world. A particular focus was assisting science academies in becoming important advisers to their governments and public regarding policy issues where science is relevant. In 2000 the InterAcademy Medical Panel was created with a similar purpose for medical academies. In 2003 the InterAcademy Council was formed to undertake studies at the global level for the UN and other international decision-makers. It operated under a board of science academy leaders from fifteen countries and under procedures similar to those of the U.S. National Academies. More recently all three organizations are being united as the InterAcademy Partnership (IAP), with the InterAcademy Panel, the InterAcademy Medical Panel, and the InterAcademy Council becoming IAP Science, IAP Health, and IAP Policy, respectively.

The IAP currently has 140 national academy members, four global and regional academies, and four regional networks. The significance of IAP's work is illustrated by its studies and statements. Reports of expert studies include: Climate Change Assessments: Review of the Processes & Procedures of the IPCC, Responsible Conduct in the Global Research Enterprise, Supporting the Sustainable Development Goals: A Guide for Merit-Based Academies, Opportunities for Future Research and Innovation on Food and Nutrition Security and Agriculture: The InterAcademy Partnership's Global Perspective (with separate reports on Africa, Asia, Americas, and Europe), Harnessing Science, Engineering and Medicine to Address Africa's Challenges: the Role of African National Academies, Improving Scientific Input to Global Policymaking with a Focus on the UN Sustainable Development Goals, and Decarbonization of Transport: Options and Challenges. The study on the IPCC was requested by the UN Secretary General. It helped to strengthen IPCC processes and procedures and restore international confidence in this important institution.

Statements endorsed by the IAP academies include: Urban Development, Transition to Sustainability, Mother and Child Health, Calling for a Ban on Reproductive Cloning, Science Education, Science and the Media, Scientific Capacity Building, UN Millennium Development Goals, Biosecurity, Ocean Acidification, Tropical Forests and Climate Change, Population and Consumption, Action to Strengthen Health Research Capacity in Low and Middle Income Countries, Antimicrobial Resistance: A Call to Action, Realizing Global Potential in Synthetic Biology: Scientific Opportunities and Good Governance, Reproducibility of Biomedical Research: A Call for Action, and Science and Technology for Disaster Risk Reduction.

An additional effort for strengthening African science academies as public health advisers to African governments was the African Science Academy Development Initiative (ASADI).(5) This network created

in 2004 and funded for ten years by the Gates Foundation produced a number of studies on health issues of importance to Africa. All together these multiple efforts of science academies have helped to strengthen the role of science advice to governments and the public in developing and developed countries.

Our Common Journey: A Transition Toward Sustainability

Following the United National Conference on Environment and Development in 1992, known as the Earth Summit, the focus on sustainability issues increased significantly, including the role of science and technology. With the support of the George and Cynthia Mitchell Foundation, the National Academies produced the report *Our Common Journey: A Transition Toward Sustainability* (1999). The title echos the famous Brundtland Commission report of the previous decade, *Our Common Future*. There is a line in the 1999 report that is especially significant emphasizing the journey that is needed. It emphasizes creation of a partnership between the scientific community and society to engender a journey of learning and doing, adaptive management and social learning, in addressing global goals. As the study stated, "Any successful quest for sustainability will be a collective, uncertain, and adaptive endeavor in which society's discovering of where it wants to go is intertwined with how it might get there." The study also reinforced using knowledge "intelligently in setting goals, providing needed indicators and incentives, capturing and diffusing innovation, carefully examining alternatives, establishing effective institutions, and, more generally, encouraging good decisions and taking appropriate actions." This report had an influence when the UN created a mandate in 2015 to strengthen the science-policy interface as part of its 2030 Agenda for sustainable development approved by almost all countries of high, middle, and low income.

PEPFAR, USAID Global Development Lab, AAAS Science and Technology Policy Fellows, and Jefferson Science Fellows

The President's Emergency Plan for AIDS Relief (PEPFAR) was launched by President George W. Bush in 2003. It is an unprecedented effort of over $80 billion invested in HIV/AIDS treatment, prevention, and research with special focus on Sub-Saharan Africa. The program's creation was greatly influenced by President Bush's visit to Uganda in 2003. Initiating PEPFAR is well described in Ambassador Jimmy Kolker's article "A Diplomat's Perspective on Using Science and Evidence in Implementing PEPFAR."(6)

The USAID Global Development Lab was created in 2014 to focus on STI for development. In many ways it is the incarnation of the ISTC idea proposed four decades earlier. Its purpose is to produce breakthrough development advances that can be scaled to bring benefits to many people. Its partnerships with foundations, private companies, and foreign institutions has leveraged more than $16 billion of non-USG funds. It has sponsored Grand Challenges, breakthrough awards, funding to support foreign scientists collaborating with U.S. scientists, entrepreneur accelerators, and university centers among its many creative programs.

The AAAS Science and Technology Policy Fellowship Program, created in 1972, now places more than 250 fellows each year serving in the agencies of the U.S. government and Congress, including the State Department and USAID. After their two-year fellowship experience, a number of fellows have become civil servants in the State Department greatly increasing the number of people there trained in S&T. The Global Development Lab expanded the number of fellows at USAID, including a third year for select fellows to work in USAID overseas offices in developing countries.

The Jefferson Science Fellows program was created in 2003 for tenured science and engineering faculty at American universities to spend a year working on policy or international development in offices at the State Department and USAID. Over 170 fellows have served to date, and they have made significant contributions to America's foreign policy and development programs.

State Department and the UN: Science Diplomacy, STAS, MDGs, SDGs, TFM, and CRDF Global

The position of Science and Technology Adviser to the Secretary of State (STAS) was created in 2000 based on a recommendation of the 1999 National Academies report *The Pervasive Role of Science, Technology, and Health in Foreign Policy: Imperatives for the Department of State*." With six advisors each serving up to three years, the STAS office has focused on many aspects of science diplomacy by including engaging with many countries around the world on science, technology, and innovation and science advice to governments. Science diplomacy has been an important asset for U.S. diplomacy.

The eight UN Millennium Goals were created in 2000 to focus for fifteen years on the poorest countries. The ambitious goals with targets and indicators were to: eradicate extreme poverty and hunger; achieve universal primary education; promote gender equality and empower women; reduce child mortality, improve maternal health, combat HIV/AIDS, malaria and other diseases; ensure environmental sustainability; and achieve a global partnership for development. Progress was uneven among countries, but some countries did well. Major reductions in the number of people living in extreme poverty were achieved.

The seventeen Sustainable Development Goals (SDGs), covering social, economic, and environmental goals with targets and indicators applying to all countries, was approved in 2015 as the key element of the UN 2030 Agenda. The Technology Facilitation Mechanism (TFM) was created to strengthen the "science-policy" interface for harnessing science, technology, and innovation (STI) for achieving the SDGs. The TFM includes an annual Multi-Stakeholder STI Forum at the UN each year, an InterAgency Task Team (IATT) consisting of a representative from each of more than forty UN agencies and international organizations, and the 10-Member Group consisting of non-governmental experts to advise on STI for making progress on the SDGs. Many developing and developed countries have been active participants in the activities of the TFM.

CRDF Global was created twenty-five years ago under its founding name, U.S. Civilian Research and Development Foundation for the Independent States of the Former Soviet Union.(7) The initial mandate was to "stop the brain drain of the region's scientists and engineers, prevent the proliferation of weapons technologies, and create mutually beneficial economic and development opportunities between the U.S. and Post-Soviet states." In subsequent years the name was changed to CRDF Global as the geographic reach expanded to include the Baltics, Middle East, Africa, Asia, and Latin America. Its programs expanded to include "entrepreneurship, international exchanges, global health, and higher education institution building" among others. Much of the work has been conducted with funding from the U.S. State Department and other federal agencies. Among the elected officials instrumental in the creation of CRDF Global was Representative George E. Brown. For a number of years CRDF Global presented annually the George E. Brown award for international scientific cooperation.

IIASA, ISC, INGSA, and the Global Solutions Summit

International S&T non-governmental organizations (NGOs) that are networks have become powerful forces for addressing national and global challenges including sustainability and S&T for development.

The International Institute for Applied Systems Analysis (IIASA), which celebrates its fifty birthday in 2022, was created as an initiative of the United States and the Soviet Union to enable their scientists to work together to apply systems analysis to problems of common interest. IIASA now has many participating countries represented by national member organizations, and carries out work on some of the most important challenges facing the world. Among influential initiatives launched by IIASA is The World in 2050 project, which has presented three reports to the UN High Level Political Forum beginning in 2018. Among the insightful analysis is an exploration of big transformations required for achieving sustainability. The key areas are: (i) education, gender, and inequality, (ii) health, well-being, and demography, (iii) energy decarbonization and sustainable industry, (iv) sustainable food, land, water and oceans, (v) sustainable cities and communities, and (vi) digital revolution for sustainable development.(8)

The International Science Council (ISC) united the International Council for Science and the Social Sciences Research Council in 2018. It is an international non-governmental association with forty international scientific unions and associations and over 140 national and regional scientific institutions.(9) The Council's strategic plan for 2019-21 encompasses science for policy, policy for science, and scientific freedom and responsibility. Aspiring to be the international voice for science, ISC conducts many meeting and produces significant reports addressing a wide variety of issues where science input is needed, including sustainability issues and development issues. ISC is co-convener of the UN Major Group for Science and Technology.

The International Network for Government Science Advice (INGSA) was created in 2014. The list of activities and programs undertaken by INGSA over the past five years are quite extraordinary: (i) a network of over 5,500 members from developed and emerging countries throughout the world, (ii) capacity-building workshops in more than fifteen countries, (iii) training more than 1,700 individuals including policy-makers, senior scientists, and early-career scientists, (iv) dialogues and focused meetings in a range of countries involving more than 1,000 participants and jointly organized with local institutions and often with international institutions, (v) advisory services provided with a range of countries, (vi) creation of an open platform for information exchanges, (vii) a vibrant social media presence, (viii) development of a catalog of case studies, (ix) sponsoring its own international and regional conferences, (x) financial support raised from governments and philanthropies, (xi) partnerships with international and national organizations, (xii) becoming an autonomous entity of the International Science Council, (xiii) supporting research associate grants and fellowships, (xiv) a science diplomacy unit that works with the Foreign Ministers Advice Network (FMSTAN), (xv) recipient of science diplomacy awards by the American Association for the Advancement of Science and the Science Forum South Africa, and (xvi) and ongoing work and reports on key issues such as response to the COVID pandemic, the role of science, technology, and innovation for achieving the Sustainable Development Goals, societal resilience, the digital future, and assisting the Global South.

The Global Solutions Summit (GSS) was initiated in 2014, and a second Forum was held at the Clinton Library in 2016. In 2018 and 2019 Forums were held at the UN prior to each year's STI Forum. The focus of GSS is technology deployment for the SDGs. In answering the question why deployment is so important, the GSS answers: "Harnessing STI for the SDGs starts with the work of scientists and engineers who develop high-performance, low-cost technological solutions for the SDGs. But this is only the first step on the long road from the lab to the SDG. The indispensable next step entails transforming these scientific discoveries into affordable products and services and getting them into the hands of the hundreds of millions of people in tens of thousands of urban and rural communities in dozens of countries."(11)

STI for SDGs Roadmaps

An innovative aspect of the TFM is the IATT's creation of working groups to focus on specific issues and initiatives. One of the most promising is the working group on "STI for SDGs roadmaps." A pilot program is underway where five countries — being assisted by several UN agencies, the Government of Japan, the World Bank — are preparing their STI for SDGs roadmaps.

The STI for SDGs roadmap is an action plan frequently updated and improved with input from the STI community and others on what is and not working. The roadmap is also the common part of three other plans: the country's national development plan, its STI capacity building plan, and its plan for achieving the SDGs. The intent is to engage not only prime ministers, finance ministers, S&T ministers, and all other government ministers, but also to engage all stakeholders in society in preparing the roadmap. The IATT working group has developed a informative guidebook for preparing these roadmaps.(12)

Five pilot countries - India, Kenya, Ethiopia, Ghana, and Serbia - are now preparing their roadmaps. Other countries from the South are watching the progress and may decide to join the effort to prepare their own plans. The roadmap concept is also applicable to all levels of government, from local to global, as well as non-governmental institutions and private companies. They could all benefit from preparing their roadmaps for how they can contribute towards harnessing STI to help achieve local, national, and global goals.

S&T for Development After Covid-19

Even with the failures at the national and global level regarding the pandemic, the global scientific community around the world did respond well, with unprecedented scientific collaboration and sharing of information. The world is relying on science and technology to provide the ultimate solutions for defeating SARS-COV-2 and COVID-19. Although the U.S. government is not currently participating, the global efforts to share therapeutics and vaccines with lower and middle income countries is proceeding. Yet the full impact of the pandemic on the developing world is still unfolding. The potential is for devastating outcomes for the poorest people on the planet. Multilateral collaboration and financial assistance are essential to blunt the tremendous negative impact to the economies and public health infrastructure of developing countries. The next pandemic can be dealt with effectively for all countries only if we strengthen multilateral collaboration and partnerships.

To effectively connect our pandemic responses to our global goals, the worldwide scientific community will need to work in partnership with diplomats, decision-makers, and the public to: (1) ensure COVID-19 rescue funds accomplish the multiple goals of eliminating the pandemic, restoring livelihoods, and achieving greater sustainability and resilience of our societies, (2) reduce barriers to international scientific collaboration and enhance international collaboration and coordination among countries to help develop solutions to our national and global problems, (3) strengthen public trust in science, and (4) reduce inequalities in societies.(13)

The national interest of the United States, as well as that of other developed countries, is to make all countries of the world more resilient, prosperous, secure, peaceful, sustainable, and democratic. The strategy for accelerating S&T for development embraced by BOSTID under Vic Rabinowitch's tenure is as vital today as it was then. That strategy encompasses helping middle and low-income countries: (i) to

build their science, technology, and innovation ecosystems, (ii) to enhance their science advisory ecosystems for providing scientific input into societal decision-making, (iii) to enable multilateral cooperation and international scientific cooperation to make progress on each country's social, economic, and environmental goals, and (iv) to work together to make progress on the global goals that will protect and sustain humanity and the planet.

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