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Women and Science, Engineering, and Technology (SET) in the Asia Pacific Region: A View from the Pacific Science Association¹

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Introduction

In 1999 Federico Mayor, then Director General of UNESCO, wrote the following in the preface to *Women, science and technology: Towards a new development* (UNESCO 1999):

“On a worldwide scale, science—and even more technology—is still a man’s business. This situation is no longer acceptable. It is economically unacceptable because of the waste of human resources that it entails; it is humanly unacceptable since it prevents half the population from taking part in building the world; it is intellectually unacceptable as it deprives scientific and technological research of ideas and methods, in a word, of creativity. Furthermore, it mortgages the future since it nullifies any prospect of a general mobilization in support of science in the service of a lasting peace and sustainable development.”

Science, engineering, and technology (SET)² are an integral part of the human experience—we have employed science, engineering, and technology in our efforts to address our basic needs—food, water, clothing, shelter, medicine, transport throughout our history. Scientific, engineering, and technological advances continue to play pivotal roles in the lives of people across the globe, and arguably affect them in ever more numerous and complex ways; some, like better medical understanding and technology, improving the lives of those who have access to them, and others, like the automobile, bringing not only benefits but detriments like pollution and environmental degradation.

¹ This paper relies heavily on two previously published overviews Pacific Science Association (1996) and Lewis (1997).

² While early discussions of the issue generally utilized the phrase “science and technology” or S&T, increasingly people are utilizing the more inclusive phrase ‘science, engineering and technology’ or SET. In this paper, SET is used unless the data, quotes or programs refer specifically to S&T.

Science, engineering, and technology do not involve or benefit people equitably. People continue to both benefit and suffer from advances in SET differentially according to their geographical location, their socioeconomic status, their ethnicity, and their gender. Similarly, certain parts of the world, and groups in society, have been able to play larger roles in the development and application of SET than others. Women traditionally have been intimately involved in the “informal” science, engineering, and technology arena—they have been and continue to be the holders of traditional medicinal knowledge in many cultures and they have been and continue to be responsible for most of the daily activities that provide food, water, and other basic needs for their families. And yet, in industrialized societies today, women have been to varying degrees excluded from SET development, policies, and discussions.

While there are differences across the sciences (e.g., the feminization of some of the health, social, and biomedical sciences) and from country to country, the structure of science remains highly patriarchal with gender bias and sexism tilting the playing field. Women are disadvantaged at all stages of a science career and relatively few women achieve the highest levels in universities, research institutes, and national organizations where decisions about research, funding, and science policy are made. This can be seen as a dichotomous sticky floor/glass ceiling phenomenon (Ghosh 2005).

Why Care about Women in SET?

At the dawn of the new millennium critical demographic, political, environmental, and development challenges face the human community. Not only the scientific community but increasingly politicians and policy makers are recognizing that the participation of women and other under-represented groups in science, technology, and engineering must be increased. This is more than a concern about equity—it is about having the human resources to address the critical challenges.

While women’s role in the SET arena varies from country to country across the region, the relative scarcity of women in SET raises questions concerning the very nature of the scientific endeavor and its relationship to global challenges.³ Almost a decade and a half ago the then chair of the United States National Research Council (USNRC) Committee on Women in Science and Engineering and president of Radcliffe College, Linda Wilson, gave four compelling reasons for enabling the full participation of women and minorities in the scientific enterprise:

1. Equitable treatment of all human beings based on human and civil rights.
2. An economic argument for the need for a skilled workforce.
3. Women and minorities can be an important source of renewal in science.
4. A “public will” argument suggesting that the U.S. needs an informed scientifically literate citizenry to address the serious issues that we face and sustain these efforts in the long run (Wilson 1992).

³ This section relies heavily on an earlier paper by Nancy Lewis, “The Pacific in a Global Arena: Building on Diversity,” presented as a plenary address at the 29th International Geographical Congress in Seoul, Korea, August 14-19, 2000.

These same arguments can be made in the international arena and may be particularly critical in the Asia Pacific region, which contains almost 60 percent of the world's population, but currently only one third of the world's higher education enrollments and only 28 percent of the world's wealth (UNESCO 2003). Globally, 70 percent of the world's poor are women.

In addition, women and other groups bring different perspectives and questions to the SET table, often resulting in advances in scientific understanding. As women have begun to play increasingly prominent roles in the biomedical sciences, for example, they have insisted that more attention be paid to how women's physiology differs from men's and its differing relationship to health and disease. Women in medicine are focusing attention on diseases and conditions that primarily affect women, too long ignored (Thom 2001) and the special risks to women of diseases like heart disease that have been investigated primarily in male populations.

Dr. Shirley Malcom, director of the Education and Human Resources Division of the American Association for the Advancement of Science (AAAS) and co-chair of the UNCSTD⁴ Gender Advisory Committee with Dr. Farkonda Hassan of Egypt, has made similar points. She argues that science and technology do not reach their full potential when "other" perspectives are missing. When women and other groups and cultures are excluded, other ways of viewing the world are lost (Huyer and Westholm N.D.). There has also been a growing recognition in recent years of the need to ensure not only that women's participation in SET increases, but also that SET development, application, and policies are shaped to address women's specific needs, especially those of rural and poor women (UNESCO 1998, Chennai Declaration 1996).

Early discussion of the gender/SET interface occurred in Copenhagen at the 1980 World Conference of the U.N. Decade for Women: Equality, Development, and Peace. At each subsequent world conference on women, as well as at subsequent international conferences focusing on science, sustainable development, and related topics, the issue of the importance of SET to our common future, and the engagement of all groups—including women—in SET have been an important topics (UNESCO 1998). A number of organizations at the regional, global, national, and local levels have initiated efforts to address the gender and SET issue during the period since these early discussions, although it has only been in the past decade or so that the gender/SET interface has begun to receive widespread international attention in the Asia Pacific region.

Regional Organizations and Initiatives

UNESCO has played an important role in promoting women in SET. The UNESCO Regional Science Bureau for Asia and the Pacific in Jakarta hosted the first "International Workshop on Women and Technology in South East Asia and the Pacific" in early 1996, although there had been earlier regional initiatives. Among these were the IFIAS⁵, WISE Thailand⁶ and

⁴ U.N. Commission on Science and Technology for Development

⁵ International Federation of Institutes for Advanced Study

⁶ Women in Science, Thailand

APPROTECH Asia⁷ symposium on “Mainstreaming Women in Science & Technology” held in Bangkok in 1992 and the symposium held at the Beijing Pacific Science Congress in 1995 (discussed below). The UNESCO meeting led to the formation of the Regional Secretariat for Gender Science and Technology (RESGEST) in Southeast Asia and the Pacific a year later. RESGEST is a collaboration between the UNESCO Jakarta office and the Indonesian Institute of Sciences (LIPI). It was initially funded by the Gender Advisory Board of the United Nations Council for Science, Technology, and Development. The primary focus of RESGEST is “women for science;” that is, promoting opportunities for women to participate in meaningful ways in SET activities in the region (UNESCO Jakarta under Home/Field of Activities/Sciences/Basic Science/Gender Equity in Science and Technology).

Another seminal meeting occurred in late 1996 when scientists and technologists gathered in India and generated the Chennai Declaration, a ten-point agenda focused on women in science and technology and the other half of the equation, “science and technology for women.” Out of this meeting and the commitments and relationships it spawned, the Asia Pacific Gender Equality Network (APGEN) was formed in 1998. Funded by UNDP, its purpose is to increase “regional coordination and cooperation towards addressing issues of feminization of poverty and gender inequality in decision making.” (UNDP under APGEN). APGEN has several programs, including “Using Science and Technology for Women’s Economic Empowerment.” Under this program UNESCO and UNDP collaborated to establish APGEST – Asia Pacific Gender Equity in Science and Technology, a project whose primary objectives are to ensure that science’s benefits are accessible to women, especially poor women, that it directly addresses the issue of feminized poverty, and that it is used towards the goal of “sustainable and equitable” development (Gender Advisory Board under WIGSAT).

UNESCO Jakarta also funded a number of the participants in the Regional Preparatory Meeting for the World Conference on Science that was held in early 1999.⁸ And the meeting entitled “Women and gender, science, engineering, and technology,” held in Sydney, December 1-5, 1998,⁹ provided the opportunity to explore issues related to the Asia Pacific region.

In reviewing the issue of women and SET during the four United Nations conferences on women, four major issues emerged with respect to advancing women in SET:

1. Education and training in SET;
2. Ability to use SET to improve their living conditions;
3. Ability to develop SET or to become scientists and technologists and the ability to participate in decision-making processes and structures or in directing the development and application of SET, including the setting of priorities; and finally,

⁷ Asian Alliance of Appropriate Technology Practitioners, Inc.

⁸ Participants hailed from Australia, Bangladesh, China, Fiji, India, Indonesia, Kiribati, Korea, Laos, Malaysia, New Zealand, Pakistan, Papua New Guinea, Philippines, Samoa, Solomon Islands, Sri Lanka, Thailand, Tonga, Uzbekistan, Vanuatu, and Vietnam.

⁹The 1998 Sydney meeting was organized in part as a prelude to the UNESCO World Conference on Science held in Budapest, June 26–July 1, 1999.

4. Elimination of negative impacts, particularly of the new technologies such as biotechnology, information and communication technology, on women” (UNESCO under science/WCS/meetings).

Further emphasis on the importance of gender equity in S&T at the 1999 World Conference on Science resulted in funding for the APGEST program and the beginning of a series of formalized projects, including country assessments¹⁰ to determine the status of women in S&T and S&T for women. The assessments also looked at best practices, resources, and gaps in five areas of science and technology in each country: biotechnology, green health, information technology, renewable energy, and water (Lechte 2002). APGEST is now completing its second phase in which it has focused primarily on developing “an empowering regional policy environment for APGEST practice and promotion; promoting women in science and technology; and working at the local level to implement projects that focused on sustainable technologies or best practices” (UNESCO under APGEST). Unfortunately, continued funding for these important initiatives is uncertain.

The World Conference on Science that was held in Budapest in mid-1999 and sponsored by UNESCO in partnership with the International Conference on Science (ICSU) is often cited as the meeting that directed international attention to the crisis with respect to women and science. However, as illustrated in the preceding paragraphs and further discussed below, a plethora of national and international initiatives and meetings predated that important conference. At the World Conference, however, many delegations strongly called for greater participation of women in science (UNESCO 1999). See Box 2 for other regional international organizations and initiatives focusing attention on the issue of gender, science, and technology in the Asia Pacific region.

UNESCO also has partnered with the cosmetic company, L’ORÉAL, since the late 1990s to present annual awards to women scientists from each of five regions¹¹ who have made exemplary contributions in either the material or life sciences (alternate years). The purpose of the awards is to honor these scientists’ achievements, to encourage their continuing research, and to present role models in the sciences for girls and women across the globe. UNESCO-L’ORÉAL also present annual fellowships to young scientists in each of the five regions to support their research and, again, to raise the public consciousness about women in science (LOREAL under For Women in Science).

The Pacific Science Association Contributions

¹⁰ APGEST assessments occurred in China, Fiji, India, Indonesia, Kiribati, Korea, Mongolia, Nepal, Philippines, Samoa and Vietnam

¹¹ Africa (including the Middle East), Asia-Pacific (including Oceania), Europe, Latin America, and North America (USA and Canada).

The Pacific Science Association¹² (PSA), which was founded in 1920 as an interdisciplinary regional scientific organization, engaged early in discussions about the issue of scientific capacity and women and science and technology.

Box 1. PSA MISSION STATEMENT

The Pacific Science Association, founded in 1920, is a regional, nongovernmental, scholarly organization that seeks to advance science and technology, broadly defined, in and of the Pacific region by fostering interdisciplinary and international research and collaboration. The Association's focus is on key issues and problems in the region with the goals of engaging science in the service of human needs and improving both the environment and the quality of life of the region's peoples. To achieve this mission the PSA serves as a catalyst for scientific and scholarly collaboration; develops scientific capacity within the region; fosters effective communication between scientists, policy makers, and the public; actively involves the Pacific Island states in regional and international scientific activities; and promotes the "Science of the Pacific."

Science education and human resource development in the region has been a concern of the Pacific Science Association for much of its history. The Association has had a Science Education Committee for nearly four decades. As noted above, the 1999 World Conference on Science held in Budapest is credited with increasing the visibility of the gender science crisis. However, almost a decade earlier in 1991 at the 17th Pacific Science Congress in Honolulu, a resolution was passed on increasing the participation of women and young scientists in Asian and Pacific science. With this initiative, the PSA initiated its specific focus on issues of gender and equity in regional science and scientific activities. A more general symposium was held on women and development at the 1991 meeting. At the next Congress in Beijing in 1995, with support from the U.S. National Science Foundation and Ford Foundation (Beijing), the Association organized a successful symposium, "Human Resources for the Future, Women and Young Scientists in Asian and Pacific Science." Thirty-five sponsored participants from twelve countries¹³ participated.

Three themes were used to organize the papers at that meeting:.

1. Human Resources for the Future: Taking Stock which dealt with education, retention and advancement, gender and science education, recruiting women, family roles, the glass ceiling, leaders in the scientific establishment, interventions and funding;
2. Science and the Role of Culture which dealt with cultural differences that enhance or hinder women's participation in science; public perceptions of science; regional comparisons; and
3. Women and the Nature of the Scientific Enquiry which dealt with women and traditional science; women, science and global change; women, science and sustainable

¹² National membership of the PSA includes: Australia, China (Beijing), China (Hong Kong), China (Taipei), France, Guam, Indonesia, Japan, Republic of Korea, Malaysia, Okinawa, Russia, Singapore, Thailand, United Kingdom, United States of America, Vietnam. The University of the South Pacific represents the Pacific Island nations. In part reflecting the political history of the region, some national units are represented by more than one adhering member, e.g., Guam and Hawaii and the United States; Okinawa and Japan; Hong Kong and China.

¹³ 1995 Beijing Congress participants hailed from China, Federated States of Micronesia, Fiji, India, Indonesia, Netherlands, Papua New Guinea, Pakistan, Philippines, Thailand, Vietnam, and the United States.

development; women shaping science; feminist critiques of science; women and scientific organizations.

A proceedings volume is available (PSA 1996). The symposium set the stage for collaboration across the region and new research and new research agendas were suggested. The need for gender-disaggregated data to help shape policy relevant initiatives was emphasized. The successful symposium led to the creation of a Division on Human Resources for the Future: Women and Young Scientists in Asian and Pacific Science as one of the standing committees of the PSA at the conclusion of the 1995 Congress.

The recommendations from that meeting emphasized the need for the PSA to work with international, regional and national organizations with relevant missions (PSA 1995). Those that were active in the mid 1990s and involved in the 1995 symposium, included the International Federation of Institutes for Advanced Study Gender, Science and Development Programme (IFIAS/GSD), Asian Alliance of Appropriate Technology Practitioners (APPROTECH-ASIA), the Gender and Science and Technology Association (GASAT), and Women in Science and Engineering Forum of Thailand (WSE Thailand).

Another successful symposium was held at the 1997 Fiji Inter-congress, “Women, Science and Development: From Indigenous Knowledge to New Information Technologies.” Women and men from across the region participated; a goal—and a measure of the success of the symposium—was the significant participation by Pacific Islanders. Participants addressed diverse topics: the need to preserve traditional medical knowledge in the Pacific; the exploration of the interface of post-colonial commercialism, identity, politics and culture in the Pacific; feminist critiques of science; women’s participation in and access to science and technology; and an overview of international and regional gender, science and technology initiatives (Lewis 1997). The proceedings were published in *The Pacific Science Association Information Bulletin* (PSA 1997).

The 19th Pacific Science Congress, held in Sydney in 1999, continued the PSA’s commitment to place issues of gender and science at the forefront of international discussions with a symposium entitled “Women and Science in the New Millennium: Science as a Career Choice for the Next Decade.” The symposium was organized in collaboration with WISENET¹⁴ Australia. Key speakers included Nancy J. Lane, a cell biologist from Cambridge University who served on UNESCO’s Scientific Committee for Women in Science and Technology and Elizabeth Heij, head of the CSIRO¹⁵ Division of Tropical Agricultural in Queensland.

The 20th Pacific Science Congress held in Bangkok in March 2003 provided the venue for a symposium and roundtable discussion on “Women, Science and Sustainability.” Lorraine Corner, Regional Economic Adviser for UNIFEM¹⁶, delivered a plenary address, “Women, Science and Sustainable Development”, and Stephen Hill, director of the UNESCO Jakarta Regional Office for Science and Technology, delivered a plenary address on the “Future of Gender and Science in the Asia-Pacific: Next Steps.” As the lead presentation in the roundtable discussion of gender and SET in the region he stressed the important parallel initiatives mentioned above, “women for

¹⁴ Women in Science Network Australia

¹⁵ Commonwealth Scientific and Industrial Research Organization

¹⁶ United Nations Development Fund for Women

science” which addresses women’s roles in the scientific enterprise, and “science for women” which address the implications of science for women’s, especially poor women’s, lives.

Illustrative Examples

Most nations in the Asia Pacific, as elsewhere, also have programs and initiatives to address women’s participation in SET. Many have policies that attempt to assure that the benefits of SET and their applications are beneficial to all women, including poor women and women in remote areas. Women’s participation in SET is increasing in many countries, but it is highly variable from country to country and everywhere women are concentrated in the lower ranks of the scientific establishment. Women are also underrepresented in institutions like the national academies, where many of the most important research and funding decisions are made. They are in the minority in almost all scientific establishments and specialties, with the exception of medicine and the social sciences in some countries.

United States¹⁷

The United States is often cited as a nation where women have made significant progress. However, in 2003 only about 8 percent of the membership of the U.S. National Academy of Sciences, the most prestigious national scientific body in the country, were women (although on a brighter note, of that year’s new members, 25 percent were women) (Hitt 2003). The comparable statistic for the U.S. Congress in 2005 is 12 percent.

While in the United States, as in every other country in the world, men unquestionably dominate science, the gap is becoming narrower. In 1970, women earned 9 percent of the U.S. doctoral degrees in science and engineering; in 1999, they earned 35 percent. In the S&E workforce the gains have not been quite as impressive: in 1973 women comprised 8 percent of the workforce; in 1999 they comprised only 24 percent, a significant gain in workforce composition over two and a half decades but not as big a gain as would be expected from the increase in women obtaining SET doctorates during this period. Also, the percentage of women with doctorates in the physical sciences and engineering workforce is much lower—13 percent and 7 percent, respectively (Association for Women in Science under research/statistics).

¹⁷ We include the United States in the discussion here not only because it is the example with which we are most familiar, but also because for both the Pacific Science Association and the East-West Center, the United States is included in the Asia Pacific region.

BOX 2. INTERNATIONAL GENDER AND SET INITIATIVES

Gender, Science and Technology (GST) Gateway is a central website that provides links to resources, partners and recommendations on GST issues in the international arena. <http://gstgateway.wigsat.org/>.

Gender Advisory Board of the UN Commission on Science and Technology for Development (UNCSTD) was established in 1995 by the United Nations to advise the United Nations Committee on Science and Technology, other United Nations programs, and national governments on the gender/ S&T interface. The GAB's seven areas for "transformative action" are: "gender equity in [S&T] education; removing obstacles to women in scientific and technological careers; making science responsive to the needs of society: the gender dimension; making the science and technology decision-making process more "gender aware"; relating better with "local knowledge systems"; addressing ethical issues in science and technology: the gender dimension; and improving the collection of gender disaggregated data for policy makers." <http://gab.wigsat.org/>.

Asia Pacific Gender Equity in Science and Technology (APGEST) is initiative on gender, science and technology funded by the United Nations Development Program's Asia Pacific Gender Equity Network and initiated by the Jakarta UNESCO Office. APGEST is currently in its second phase. During the first (2000-2002), participants assessed gender, science and technology resources, gaps and best practices in selected Asia and Pacific countries and produced comprehensive reports outlining their findings. The first phase also involved providing technical assistance on green health technology to projects in the Philippines and Thailand. During the second phase (2003-2005), participants are developing "an empowering regional policy environment for APGEST practice and promotion"; promoting women in science and technology; and working at the local level to implement projects that focus on sustainable technologies or best practice. www.unesco.or.id/apgest/.

The Regional Secretariat for Women, Gender, Science and Technology (REGEST) is housed in Jakarta, Indonesia and is sponsored by UNESCO and the Indonesian Institute of Sciences (LIPI). The Secretariat's objectives are. "to enhance the status and role of women, both as agents and beneficiaries in the development of [S&T] and their application to social and economic development, and promote studies on their differential impacts on women and men in Southeast Asia Pacific region, in line with programs of transformative actions recommended by UNCSTD." www.unesco.or.id/activities/science/basic_sci/55.php.

Women in Global Science and Technology (WIGSAT) is an international non-profit organization whose mission is "to promote the contributions women make in science and technology for development, and to help NGOs, governments, bilateral and multilateral agencies and women themselves to understand the gender dimensions of S&T and the implications of this for development policy and practice." www.wigsat.org.

The Third World Organization for Women in Science (TWOWS) is an independent, non-profit group established in 1993 whose objectives include to increase access, education and opportunities for women from developing countries in science and technology and to provide a forum for international exchange and discussion among women in S&T. www.twows.org/.

The Association for Women in Science (AWIS), the American Association for the Advancement of Science (AAAS) and the Women in Engineering Programs and Advocates Network (WEPAN) collaborated to form **The Global Alliance for Diversifying the Science and Engineering Workforce**, whose purpose is to "support efforts to diversify the global engineering and science workforce; increase the role and participation of women in the science, math, engineering and technology (SMET) workforce worldwide; and support other areas of diversity, including social groups, ethnicity, age, discipline, languages, and cultures." www.globalalliancesmet.org/.

Asia Pacific Economic Cooperation (APEC) formed a Women's Leaders Network. The Network actively promotes women and SET. In 1996, APEC held a forum on 'Gender and Science and Technology in Knowledge Based Economies' at the Second APEC Ministers' Conference on Regional Science & Technology Cooperation in Korea. Out of this forum came a commitment to identify and promote strategies to (1) increase women's access to advanced education in S&T and (2) increase women's participation in high-level S&T activities. Another meeting held in 1997 led to a number of recommendations to do with promoting women in S&T, acknowledging women's traditional contributions to S&T, and considering how technology impacts women adversely and beneficially. www.apec.org/.

International Women in Science and Engineering (IWISE) has goals of enhancing the status of professional women scientists from developing countries and countries in transition and to assist them in their efforts to improve conditions in their home countries. These goals are furthered by providing women scientists with opportunities for collaboration in their scientific areas, leadership training, and support of projects they undertake that will improve the educational and social environments in their home countries." www.iitap.iastate.edu/iwise/about.html.

WITI (Women in Science International) is a non-profit organization whose mission "is to empower women worldwide to achieve unimagined possibilities and transformations through technology, leadership and economic prosperity." www.witi.com/.

professors (Association for Women in Science under resources/statistics). When the top 50 research universities in the country are considered, women comprise only 15 percent of the S&E faculty (Ripley, 2005). In addition, those women who do enter academia in SET experience enormous salary discrepancies despite the same credentials as men in their fields: the median salary for a man in the U.S. with a doctorate in S&E is \$81,000; for a woman it's \$62,000 (Association for Women in Science under resources/statistics). In the United States, the overall enrollment of women in engineering has plateaued and the enrollment in computer sciences has actually declined (NSF 2002). Women remain particularly underrepresented in two broad fields: computer sciences (29 percent) and engineering (20 percent) and are much less likely to be supported by research assistantships than men (NSF 2002).

Vietnam. In Vietnam, at the National Center for Natural Sciences and Technology in 1997, the most recent year available, 7 percent of the top leadership positions were occupied by women. Significantly more women were found in lower-level leadership positions (13.2 percent of division heads or deputy heads). In SET organizations country-wide, about 12 percent of leadership positions are held by women, with only 8 percent of the very highest positions occupied by women (Vietnam Working Group on GST 2001). Similarly, 4 percent of full professors and 8 percent of associate professors were women. It is promising that almost 40 percent of university/college graduates in SET were women in 2000, but SET graduates do not always translate into increasing numbers of women in related jobs, let alone, influential ones for a variety of reasons discussed below. In 1999, approximately 30 percent of the total S&T workforce in Viet Nam was comprised of women (Vietnam Working Group on GST 2001).

Viet Nam has a number of organizations and programs that are addressing gender issues including the gender/SET interface, including the Center for Research in Female Labor (CRFL), the Center for Women's Studies at Hanoi National University, and the Center for Family and Women's Studies. Many of these organizations as well as many Vietnamese women scientists are focusing not only on increasing women's participation in SET, but also providing appropriate technologies to rural and impoverished women. The National Plan of Action for the Advancement of Women signed in 1997 is another promising initiative to address the issues of women's advancement in science and elsewhere. The National Committee for the Advancement of Women (NCFAW) is an advisory body to the government on gender and development and other policies that are relevant to women, including ones to do with science and technology (Vietnam Working Group on GST 2001). In addition, Vietnamese representatives at the 2000 Regional Workshop on Gender, Science and Technology in Jakarta committed to improving the collection of statistics, working with national entities to focus on increasing women in S&T, working with other partners in the region to address shared environmental problems, and hosting a workshop on GS&T in Vietnam (RESGEST 2001).

Japan. Like all countries, Japan faces challenges as it works to increase the meaningful participation of women in the SET workforce. Cultural attitudes and beliefs about women's abilities and roles are deeply rooted and affect girls and women throughout their educational and professional lifetimes. As elsewhere, there are issues of covert discrimination in terms of hiring, advancement, salaries and funding, but also, all too often, overt discrimination and harassment

(Cyranoski 2001). In addition to expectations about women's primary roles as mothers and wives, another commonly held belief which has a detrimental effect on women's participation in the SET workforce is that a person's career needs to be established by her early 30s, a time when many women are taking time off to have and rear children (Cyranoski 2001).

Women comprise almost 50 percent of graduate students and post-docs in science but there are few women professors in these fields, and those that do exist are concentrated, again, in the lower positions (Cyranoski 2001, Craft 2002). The results of a 2002 survey conducted at the pre-eminent University of Tokyo indicate that at that time less than five percent of the teaching staff were women (Kite 2005). Women comprise just one-fifth of one percent of the boards of publicly listed and private companies (Ghosh 2005).

The Japanese government, as well as many prominent SET organizations, has been taking steps to address the problem. The Cabinet Office established the Council for Gender Equality in 2001 with the purpose of ensuring gender equality in all areas (Riken Brain Science Institute 2002). The Japanese Science Council has committed to having 10 percent female membership by 2010. Government Committees are committed to raising the percentage of women members to 30 percent by 2005. The Japan Association of National Universities has committed to fill 20 percent of permanent research positions with women by 2010 (in 2001 this number was 7 percent) (Cyranoski 2001). The Chemical Society of Japan, which over the course of its one hundred and twenty seven year history can boast just two women board members, has now pledged to hold one of 26 board membership slots for a woman (Kite 2005). And the Canada-Japan Women in Science, Engineering and Technology (WISSET) Exchange Lectureship program, an initiative between Japan and Canada to promote women in SET, is now underway. Women scientists and engineers from each of the two countries are invited to give lectures to a variety of groups from school children to research institutions in the other country on the topic of women in scientific, technological and engineering research. The goal is to make women in SET more visible and accessible to young people as well as to facilitate international working relationships (The Royal Society of Canada 2004).

Indonesia. Indonesia faces similar challenges. Less than 30 percent of the S&T workforce is female and few women are in leadership positions in the S&T realm (GST Working Group of PAPIPTEK-LIPI 2001). In 1997, there were some women in ministerial leadership positions (1 out of 17 heads of R&D agencies); in 2000, one out of five Deputy Ministers was a woman and 7 out of 21 deputy assistants were women. Women comprise only around 7 percent of the senior researchers at LIPI, the Indonesian Institute of Sciences. In 2000, 11.5 percent of the membership of the National Research Council (DRN) was female (RESGEST 2001). Graduation from college is another area of gender imbalance. In 1998, women comprised only 22 percent of graduates from domestic universities and 13 percent of graduates from foreign universities (RESGEST 2001).

Indonesia has a number of initiatives underway to address this issue including the establishment of the State Ministry for the Empowerment of Women, the passage of Presidential Instruction No. 9/2000 in 2000 regarding gender mainstreaming in national development, and the IPTEKDA¹⁸ program, one objective of which is to empower women through use of S&T.

¹⁸ S&T for Community Development Program

WomenWatch, UNIFEM and UN ESCAP all have activities geared toward addressing the issues associated with women and S&T in Indonesia. High illiteracy rates and cultural mores about women, as in many places, are hindering some efforts to increase participation of women in SET activities, particularly in rural areas (GST Working Group of PAPIPTEK-LIPI 2001). Indonesian participants at the 2000 Regional Workshop on Gender, Science and Technology in Jakarta committed to several courses of action, including improving data collection, performing a national assessment of how S&T are benefiting women in rural areas, and compiling directories of institutions and experts in GST (RESGEST 2001).

China. In 1999, about 35 percent of the S&T workforce as a whole and 8 percent of those in the highest decision-making positions in S&T were women. A little more than 15 percent of the Chinese Association for Science and Technology leaders are women. In the Chinese Academy of Sciences (1999), around 20 percent of senior research fellows were women, but only just over 10 percent of the highest level of leadership positions were held by women (CAST 2001).

The Chinese Association for Science and Technology's (CAST) Department of Children and Youth Affairs has been working with UNICEF since 1994 to increase access to educational opportunities, including in the area of science, for girls in 120 poor counties (RESGEST 2001). Each country that participated in the 2000 Regional Workshop on Gender, Science and Technology in the Asia Pacific agreed to initiate certain activities and projects to address GST. China committed to: establishing a research committee on gender, science and technology at the Beijing Normal University, working to build partnerships with government and nongovernmental organizations on GST issues, and working jointly with regional partners to address pertinent GST concerns.

Philippines. The 1990s in the Philippines saw a host of gender-related government initiatives. Women's participation in government S&T leadership positions increased substantially between 1984 and 1993 from 13 percent of total to 40 percent of total, a very impressive gain in less than a decade. Nearly three quarters of the Philippines National Academy of Sciences are men, 26 percent are women. While men clearly still outnumber women in this influential institution, women comprise a higher percentage of the National Academy than in most other Asia Pacific countries. Recipients of the National Academy Young Scientists award are also predominantly male, although nearly a third are women, which is a much higher percentage than most other countries in the region can claim. At the 2000 Regional Workshop on Gender, Science and Technology in Jakarta, the Philippines representatives agreed to begin hosting a website that focuses on gender science and technology issues and work to increase the reporting of gender-disaggregated data at national institutions, among other initiatives. There is no doubt that the Philippines is making important strides toward gender equality in the SET arena, but like all other countries, needs to continue to advocate for women's role in SET development and application (RESGEST 2001, PCARRD and DOST 2001).

The preceding examples are from just a few countries in the region. There are efforts in all countries to promote women in science. The recently released International Council for Science (ICSU) draft IV "Priority Area Assessment on Capacity Building in Science" includes the recommendation (12): "The ICSU family should work with its partners—including the Organization for Economic Cooperation and Development, UNESCO, and other UN bodies (e.g.,

the Gender Advisory Board)—to improve the participation of women in science, including efforts to make science education more accessible and to harmonize careers in science with work life and family life.” It also notes that half of all university students are women and excluding women creates major issues for the supply of scientists. Science in the regional and globally furthermore risks losing an important part of its pool of talent” (ICSU 2004).

Barriers to Women in SET

While it is encouraging that most countries are seeing improvements in women’s roles and participation in SET, it is nevertheless abundantly clear that women do not yet enjoy anywhere near equal participation in the science, engineering, and technology arena in any country in the Asia Pacific region, nor, in fact, the world. Why, despite several decades of awareness and efforts to address the issue, are women still under-represented in SET in general, and in its highest ranks in particular?

As noted earlier, SET remains highly patriarchal. The 1998 conference in Sydney, “Women and gender, science, engineering and technology,” identified a number of barriers to women’s participation in SET. These included: “inflexible work organization in SET careers; gender-stereotyped public images of SET cultures reflecting SET as a male-dominated area; insufficient women in decision-making roles so that interests of women, particularly disadvantaged women, are not included; design of educational systems that are not conducive to women’s full and equal participation in SET; lack of training and understanding of gender issues in SET communities; [and] lack of involvement of women in the design of technology, resulting in the production of technologies that do not respond properly and adequately to women’s concerns. In a number of cases, these technologies lead to the exploitation of women. Lack of consultation in factory design may exploit the health of women workers. Women must also have access to appropriate research processes, scientific knowledge and technologies to alleviate feminized poverty” (UNESCO 1998).

Entrenched cultural beliefs about women’s roles and innate abilities appear to play a significant role in the leaky pipeline phenomenon, whereby women fall off of the SET ladder at each rung of education/training and advancement. Women and men in many countries of the region have been socialized to believe that boys and men have a greater innate capacity for science, math, and engineering. The result is that women are more likely than men to (a) to be discouraged, wittingly or not, by teachers and others along their educational and professional paths and (b) to take setbacks as evidence that they are not fit to pursue careers in SET (Johnston 2005, Thom 2001). Moreover, in many countries, there remains a pervasive belief, including among the top SET leadership, that a woman’s role is ultimately to be a wife and mother, and that SET pursuits are better left to men.

Both men and women often hold these beliefs unconsciously and yet numerous studies have determined that they do exist and affect women directly as they are passed up for jobs, promotions, research grants, and educational funds in favor of men who may or may not be as qualified (Thom 2001, Kite 2005, Ghosh 2005, Cyranoski 2001). A 1999 study of tenured

women science faculty at MIT, one of the most prestigious technical universities in the United States, reports that "...discrimination consists of a pattern of powerful but unrecognized assumptions and attitudes that work systematically against women faculty even in the light of obvious good will." and that "the heart of the problem is that equal talent and accomplishment are viewed as unequal when seen through the eyes of prejudice." (MIT 1999). Several months ago, the president of Harvard University (a university that did not grant tenure to women physicists until 1992), Lawrence Summers, suggested that the lack of women pursuing science careers might be due to innate differences between women and men. This suggestion has drawn intense criticism from many quarters (Bombardieri 2005) and has refocused attention on gender and science issues in the United States.

The concept of "stereotype threat" refers to the threat members of groups who are associated with the stereotype feel when asked to perform in an area in which that stereotype is relevant. For example, a commonly held stereotype in many societies is that, in general, boys and men are better at math than girls and women. Several studies have demonstrated that when women are told before a math test that it is a test in which men and women do equally well, men and women will do equally well. In situations where women are either told that it is a test in which men outperform women or if they are told nothing at all (i.e., the stereotype threat has not been removed), men will outperform women. The stereotype threat also has been repeatedly demonstrated to be relevant to the performance of other stereotyped groups such as African Americans (Quinn and Spencer 2001; Clewell and Campbell 2002). The stereotype threat almost certainly impacts women's performance and aspirations throughout their educational and professional careers and contributes to the leaky pipeline. Parents, teachers, friends and mentors, indeed everyone, must start expecting girls to perform as well as boys in math, engineering, science, and technology because there is increasing evidence that if we do, they will.

Across the globe, another important reality that contributes to the dearth of women in SET is the lack of role models and mentors for girls and women (and members of other marginalized groups). Girls and women need to see successful women scientists in their classes, in their textbooks, and represented in the media. Without role models, many girls and women will not believe that they can defy cultural, societal and even familial expectations of their life trajectories to pursue careers in SET (NECUSE 1996; Association of Women in Science under resources/mentoring; Clewell and Campbell 2002). Similarly, all people benefit from mentors, and girls and women in particular need mentors that they can relate to at each stage of their educational and professional development. There is evidence that students and mentors relate best to students and mentors of the same gender and ethnicity as themselves, which underscores again the importance of having women in positions where they are able to act as role models and mentors to the girls and women coming up the pipeline (Association of Women in Science under resources/mentoring).

Another fundamental barrier to the equal and meaningful inclusion of women in SET is that science education has tended to be geared toward the learning styles and interests of boys and men rather than girls and women. University classes have been organized around a competitive model with the "weeding out" of a proportion of students often a primary and boldly stated goal. While it is hard to imagine that anyone responds well to such a message, research has indicated that women, in particular, are discouraged by a highly competitive environment, and tend to

respond better to cooperative styles of learning. Moreover, teachers in general, at least in the United States where the issue has been extensively studied, tend to be more encouraging to boys than girls from elementary school onward. Girls and women, for example, tend to be interrupted more frequently (NECUSE 1996), called on less frequently, responded to less positively, and in general receive less teacher attention (Clewell and Campbell 2002). Whether this is true across the Asia Pacific region is not clear, although since similar attitudes exist toward girls' roles and abilities in many Asia Pacific countries, we can imagine that some of these issues are observed in classrooms in other countries. Numerous studies have also pointed out that traditional science and math education curricula and methods are often geared toward boys' interests and abilities. For example, problems are developed on topics that are generally of more interest and relevance to boys than girls (NECUSE 1996, Clewell and Campbell 2002).

Another issue that affects women's involvement in SET has to do with the gendered nature of care giving and other domestic responsibilities in most societies. Women, in virtually every society, are the primary caregivers of children and the elderly, and in addition, are responsible for the bulk of domestic duties, whether they also work outside the home or not. In the United States, professional women are almost twice as likely as professional men to be married to spouses with full-time jobs, which means that while many professional men have partners who take care of children, elderly parents, and other domestic responsibilities, far fewer women are similarly free of such duties, nor do many of them want to be (Clewell and Campbell 2002).

Many systems currently in place -- for example, the academic one -- were designed with the model of a one-career family. As women increasingly enter the workforce across the region, institutions and governments need to recognize that many workers now have two careers plus family responsibilities to juggle, and make the necessary infrastructural changes to accommodate this new reality. Addressing the need for a work and family through pro-family policies such as flexible work hours, on site child care, halting the tenure clock for maternity, and so on life balance would benefit both men and women (Clewell and Campbell 2002, NECUSE 1996, MIT 2002). Sharply lower fertility rates in East Asian countries in large part reflect the tensions women experience regarding career, marriage, children and lifestyle. This certainly has implications for attracting women to demanding careers in SET.

What Still Needs to be Done

As earlier quotes by Mayor, Wilson and Malcom have indicated, there are important scientific, social, and economic costs in SET associated with the underutilization of the talents of half the world's population. This important concept received broad endorsement at the 1999 World Council on Science, It is worth thinking about how science would look like if gender perspectives were mainstreamed.

Proactive programs are needed, including ones to directly address gender bias and girls and women's perceptions of their abilities and aspirations.

RECOMMENDATIONS:

- Mainstream gender in SET.

- Promote public policy that is gender sensitive in science and technology.
- Promote the collection and analysis of gender-disaggregated data and indicators.
- Assure equal access to technology and address issues of the digital divide.
- Share best practices nationally, regionally, and internationally.
- Promote SET education that is gender-sensitive, i.e., is geared toward the interests and experiences of girls as well as boys.
- Develop mentorship programs from primary school through professional careers.
- Develop creative strategies for recruitment, retention, and advancement.
- Ensure that the “face” of science portrayed by the media includes diverse images, including women, so that all people can imagine themselves in SET careers.
- Ensure that SET activities are designed to address women’s, particularly poor women’s, needs in the effort to alleviate poverty and empower women.
- Ensure that indigenous/traditional knowledge is preserved and harnessed in conjunction with new technologies to work toward equitable and sustainable development and the preservation of biodiversity; protect intellectual property.
- Advocate for national policies/recommendations for the inclusion of women in national academies, national funding agencies, scientific organization leadership roles, and scientific related business.
- Promote recognition that the life course/career experiences of women and men are typically different for cultural and biological reasons. These need to be accommodated within a context of equity rather than equality. Promote specific policies that allow women to successfully balance work and family, such as encouraging re-entry into school and professions after time off for family responsibilities, flexible work times, childcare support, etc.

In closing.

Rita Colwell, an environmental microbiologist and scientific administrator, has recently stepped down as the president of the U.S. National Science Foundation (NSF). Writing in the preface to *The Door in the Dream* (Wasserman 2000), a book based on interviews with women members of the National Academy of Science (NAS), Colwell related that in exchanges with primarily white male colleagues in Washington, D.C., even with her prestigious position at NSF, she continued to find that her statements were frequently met with silence. The same thoughts expressed by a man somewhat later, were not uncommonly lauded as remarkable. Underscoring the continuing uphill battle for women in science, Colwell cited a 1995 study of applicants for the Swedish Medical Council postdoctoral program. Senior male scientists consistently rated women below men. An analysis of the data showed that to be ranked equally women had to attain 100 or more points for productivity and journal prestige, men only had to accrue 20 or less, giving males a five to one edge in the ranking system.

Colwell, in a quote that is reminiscent of the quote of Federico Mayor that began this paper, stresses that we cannot let this gender imbalance persist.

“Intelligence is not linked to the Y chromosome; to exclude half the population from scientific inquiry is to deny us [as a nation] an extraordinary amount of ability and intelligence. The need for scientific brain power will only increase as we proceed into an information age in which science and engineering will touch our lives like never before. Add to that the demands of global competition and it's clear that to prosper in the 21st century will require the broadest scientific contribution possible. The cost of excluding any group has simply become too high” (Colwell in Wasserman 2000; ix).

United Nations Secretary-General Kofi Anan announced the Millennium Development Goals in 2000. Millennium Development Goal 3 is to promote gender equity and empower women. Anan has argued that we will not be able to meet any of the Millennium Development Goals if we do not achieve gender equity and the empowerment of women. Striving for equal participation in SET will help to accomplish this. It will also tap a vital resource for science and bring new perspectives to scientific inquiry and our quest for sustainable development. While there are notable differences with respect to women's participation in science, technology, and engineering internationally and national trends can be observed, women are still consistently underrepresented in SET. If we, as a global society, are going to meet the pressing challenges of the decades to come, including achieving the Millennium Development Goals and attaining sustainable development, we must draw on all of our talent and assure that all parts of the globe are engaged.

The 21st Pacific Science Congress will be held in Okinawa in 2007 in association with the Science Council of Asia meeting. The overall theme has not yet been set but gender and SET will be an important part of the agenda of the 21st Congress.

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