Science and the World's Future

JST Symposium

Responsibility and Role of Scientists in Society

Tokyo

October 6, 2011

Bruce Alberts,
University of California, San Francisco (UCSF)
Editor-in-Chief, *Science* magazine

After 30 years running a research laboratory, I was suddenly selected as the full-time president of the US National Academy of Sciences

U.S. National Academy of Sciences Charter (1863)

"The academy shall, whenever called upon by any department of the government, investigate, examine… and report upon any subject of science or art ,… but the Academy shall receive no compensation whatsoever for any services to the government of the United States".

Three academy-type organizations work together to provide policy advice to the USA

THE NATIONAL ACADEMIES

National Academy of Sciences
National Academy of Engineering
Institute of Medicine
National Research Council

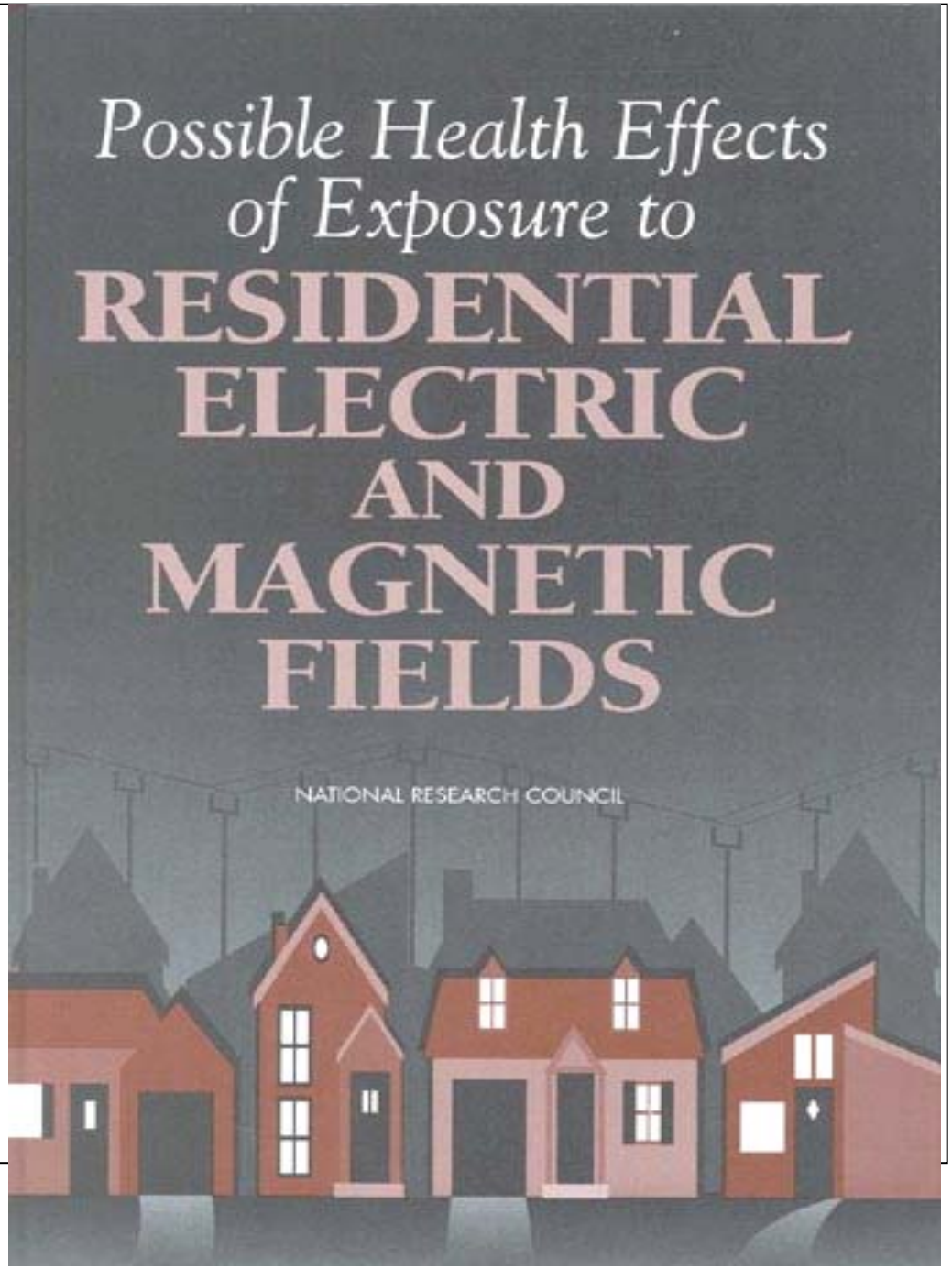
My education in Washington, DC
1993 to 2005: **a shift from science to science policy**

How the US Academies work to promote the use of science for wise decision making

I will give you two examples

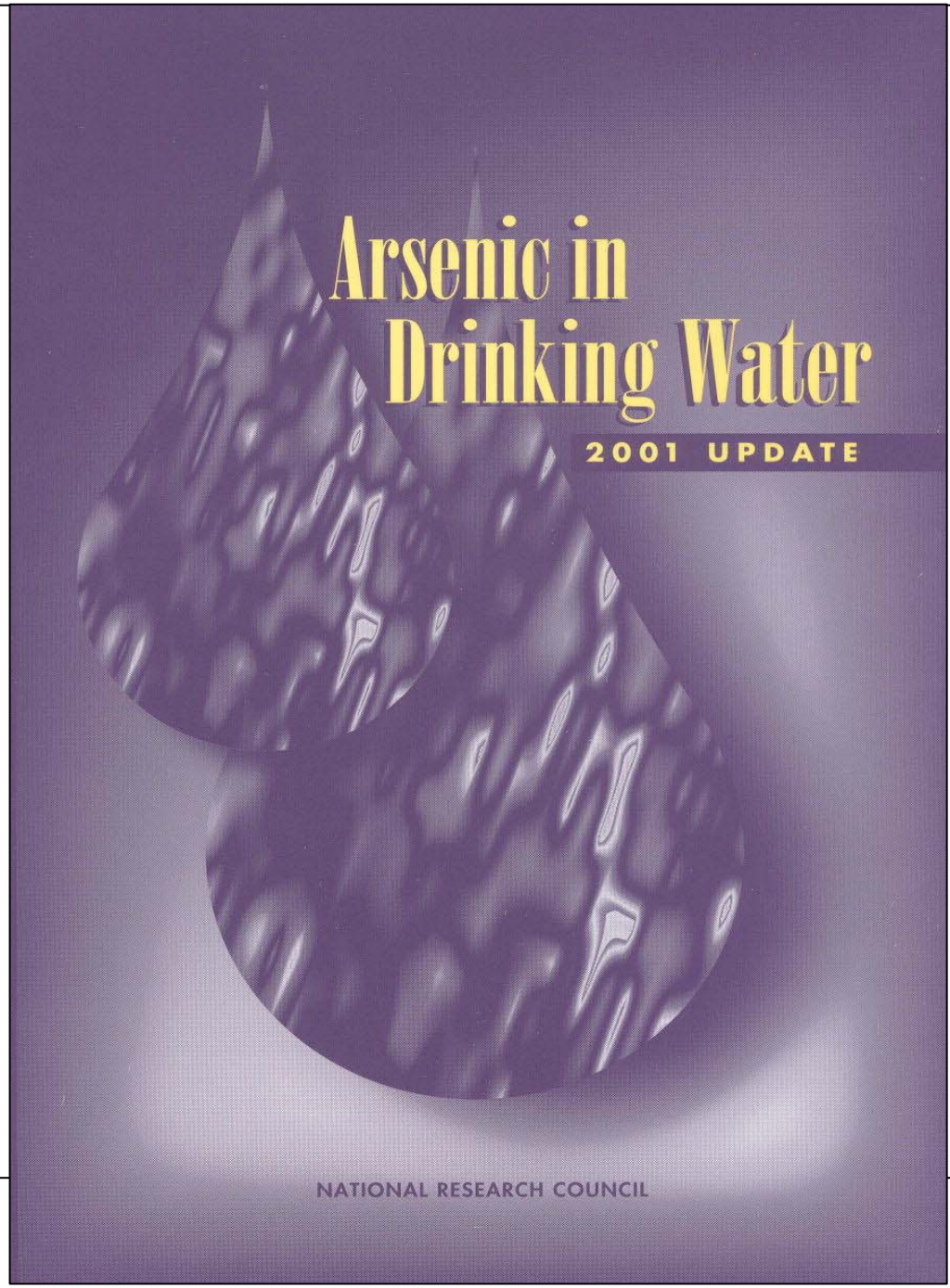
Conclusion:

No evidence that these fields are dangerous



Conclusion:

Good evidence that very low levels of arsenic are dangerous



Why scientific judgments like these are crucial for policymakers

- Science has allowed humans to gain a deep understanding of the natural world.
- In many cases, we can therefore predict the effects of current actions on the future.


I see a major increase in global warming!
SCIENCE

Independent policy advice from the National Academies

- More than 200 reports a year,

  85 percent requested by the US government

- Full text released to the press, and to the public on our Website, when report is delivered to government

Why does it work?

- Our government prides itself on “basing decisions on the best science”.

- Both sides of an argument usually claim to have science supporting it. **The Academies present the overwhelming consensus on each issue.**

- **Each committee is carefully designed** to produce a report that is balanced, with all useful scientific and technical points of view represented.

Guidelines for appointing committees

- No representatives of another organization. Each person must be **willing to learn and form their own opinion**, independent of outside pressures.
- Aim to include **all of the needed areas of expertise** on the committee (for example, a legal expert if needed, in addition to scientists and engineers)
- All possible conflicts of interest are carefully examined before an individual is appointed.
- The committee process begins with **confidential testimony from outside experts**, in order to become well-informed on all of the issues.
- Work for a **consensus**, but a brief minority opinion is allowed when this is not possible. This takes time!

Why does it work? #2:

- Through a rigorous report review processes, the Academies have made a great effort to **avoid non-scientific statements**, as required to be seen as a neutral advisor.

- Finally, **the US press pays attention** to what the National Academies say, which puts pressure on government to respond.

Weather
Today: Sunny, pleasant. High 84. Low 62.
Wednesday: Sunny, pleasant. High 80. Low 60.
Details, Page B8

The Washington Post

HOME EDITION
25¢

TUESDAY, SEPTEMBER 11, 2001

Broader Stem Cell Research Backed

Key Science Group Differs With Bush

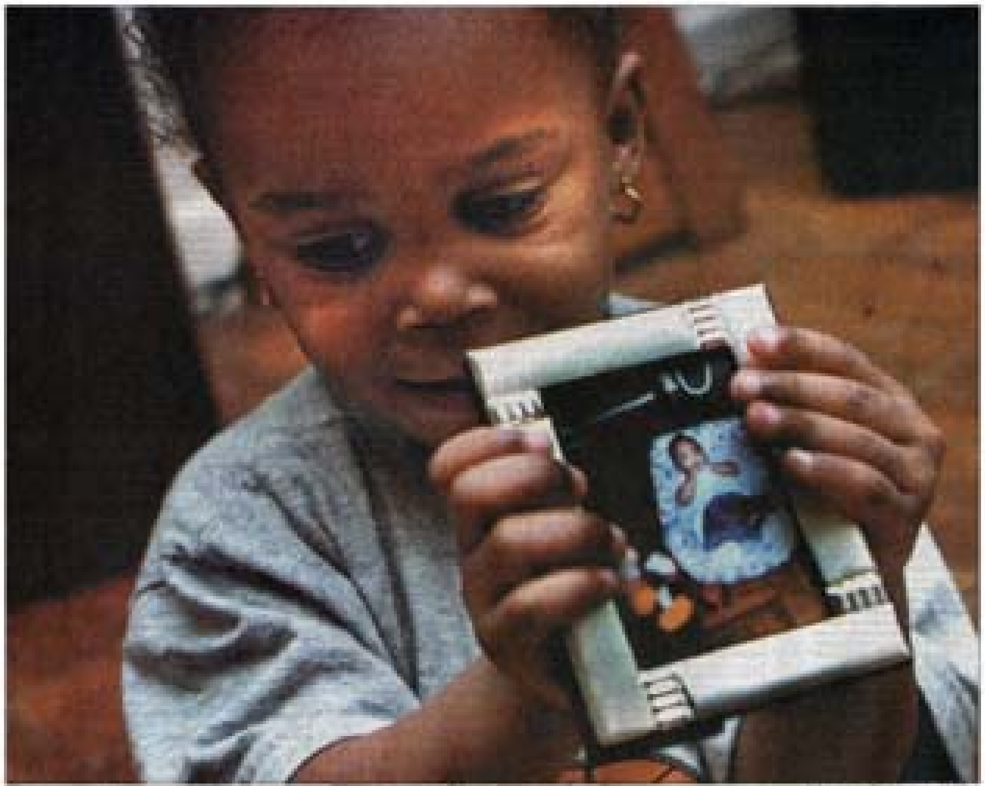
By Rick Weiss
Washington Post Staff Writer

Research on human embryonic stem cells deserves generous funding by the federal government and will not live up to its therapeutic potential if the work is restricted to a small number of cells from a limited number of embryos, according to a report to be released today by the National Academy of Sciences.

Moreover, scientists should be allowed to pursue research that involves the cloning of human embryos because cells derived from such embryos may prove to be especially useful for the treatment of many degenerative conditions, the report concludes.

The report by the academy, an independent organization chartered by Congress to advise the government on science issues, comes one month after President Bush announced his policy regarding federal funding of human embryo cell re-

THE DISTRICT'S LOST CHILDREN | *Babies at Risk*



A twin who died: *A photo of Tyrika Perry, who died at 5 months in 1999, is held by her sister.*

EPA to Urge Tighter Rules For Arsenic

Report Raises Agency Concern About Drinking Water Limits

By Eric Pianin
Washington Post Staff Writer

The Environmental Protection Agency has conclude that it must adopt a new standard for the amount of natu rally occurring arsenic allowed in the nation's drinking wa ter that is at least as tough as the one proposed by the Clin ton administration, officials said yesterday.

EPA Administrator Christine Todd Whitman decided to recommend a stringent new limit after receiving a report from the National Academy of Sciences that found that the health risks posed by arsenic are much greater than previ ously assumed by the EPA, according to agency officials.

"This increases our concern about arsenic and what the level should be," an EPA official said last night.

The decision addresses one of the most controversial en vironmental decisions the Bush administration has made since coming into office. In March, the administration set aside a Clinton administration regulation tightening the 50-year federal standard for arsenic levels in drinking water from 50 parts per billion to 10 parts per billion. The move touched off criticism from Democrats, environmentalists and moderate Republicans and prompted a House vote seeking to reverse the action.

Whitman charged at the time that the Clinton rule had been hastily crafted without adequate scientific study or consideration of the costs for small communities that would have to change their filtration systems. She ordered further examination, by the academy and other bodies

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The central lesson from my 12 years in Washington

It is critically important that science, and scientists, achieve a much higher degree of influence, throughout both their nations and the world.

In particular, we need much more of the creativity, rationality, openness, and tolerance that are inherent to science --- what Indian Prime Minister Nehru called a "**scientific temper**" -- for both the US and all other nations

My favorite quote

The society of scientists is simple because it has a directing purpose: to explore the truth. Nevertheless, it has to solve the problem of every society, which is to find a compromise between the individual and the group. It must encourage the single scientist to be independent, and the body of scientists to be tolerant. From these basic conditions, which form the prime values, there follows step by step a range of values: dissent, freedom of thought and speech, justice, honor, human dignity and self respect.

Science has humanized our values. Men have asked for freedom, justice and respect precisely as the scientific spirit has spread among them.

Jacob Bronowski,
Science and Human Values, 1956

To generate a scientific temper for a nation, we need good science education for all

What science should look like in school

What 5 year olds can do

1) Put on clean white socks and walk around school yard.
2) In class, collect all black specks stuck to socks and try to classify them: which are seeds and which are dirt?
3) Start by examining each speck with a 3 dollar, plastic “microscope”.
4) End by planting both those specks believed to be dirt and those believed to be seeds, thereby testing their own idea that the regularly shaped ones are seeds.

The Vision

Imagine an education that includes solving hundreds of such challenges over the course of the 13 years of schooling that lead to high school graduation – challenges that increase in difficulty as the children age.

Children who are prepared for life in this way would be **great problem solvers** in the workplace. Even more important, they will also be **more rational human beings –** people who are able to make wise judgments for their family, their community, their nation, and the world.

The image we want for science

Science magazine as a tool for improving the scientific enterprise

Globalizing Science Publishing

Wieland Gevers is Emeritus Professor of Medical Biochemistry at the University of Cape Town in South Africa; he was President of the Academy of Science of South Africa from 1998 to 2004.

PUBLISHING IN SCIENTIFIC JOURNALS IS THE MOST COMMON AND POWERFUL MEANS TO DISSEMINATE new research findings. Visibility and credibility in the scientific world require publishing in journals that are included in global indexing databases such as those of the Institute for Scientific Information (ISI). Most scientists in developing countries remain at the periphery of this critical communication process, exacerbating the low international recognition and impact of their accomplishments. For science to become maximally influential and productive across the globe, this needs to change.

The economy of electronic publication, open access, and property rights fuel current academic and policy debates about scientific publishing in the industrialized world. The concerns in the developing world (with few ISI-indexed journals) focus on more fundamental questions, such as sustaining local research activity and achieving the appropriate global reach of its science activities.

The essence of the African situation is captured by R. J. W. Tijssen's analysis of publications by African authors,* which was based not only on data from ISI indexing databases, but also on publications not indexed in this system. Surprisingly, half of the South African citations in the indexed ISI literature are to articles in nonindexed, locally published journals. Also, several nonindexed local journals are cited in the ISI system at about the same rate as are indexed journals. The share of indexed articles with at least one author with an African address remains steady at about 1%. About half of the ISI-indexed papers with at least one author with an African address have non-African partners outside of the continent. These figures vary, country by country, sometimes in surprising ways. For example, 85% of the papers published from Mali or Gabon involve

Science in the Future of India

C. N. R. Rao is a National Research Professor at the Jawaharlal Nehru Centre for Advanced Scientific Research in Bangalore, India, and has been chair of the Science Advisory Council to the Prime Minister of India. E-mail: cnrrao@jncasr.ac.in

INDIA HAS VOTED FOR SCIENCE. IN MAY, HALF A BILLION PEOPLE CAST THEIR BALLOTS, AND THEY decisively favored spurring the development of the world's second most populous nation. The reelected Prime Minister Manmohan Singh and his new coalition government have made a commitment to reduce poverty and disease, create employment, and stimulate rural and industrial development. Attaining these goals will require substantial new investments in science and technology (S&T) plus much greater investments in human capital.

Since achieving freedom in 1947, India has established many institutions devoted to science and higher education. Most notably, five Indian Institutes of Technology (IITs) were established between 1951 and 1963, and by 2008 there were 13 IITs: national degree-granting institutions devoted to the training of high-quality engineers and scientists. Despite the gap in infrastructure between advanced countries and India, there have been critical successes in areas such as space, atomic energy, and agriculture. In fundamental research too, India has made progress. Because of the innumerable demands on the economy, however, the higher-education sector has not received adequate support. Part of the reason for the decline in India's university science education system in the past decades has been the preferential funding for R&D activities in national research laboratories.

Prime Minister Singh has recently announced an increase in government investment in S&T from the present 1% of gross domestic product (GDP) to 2% of GDP over the next year or two, an increase of unprecedented magnitude. The contribution of industry has also increased significantly in the past few years, now amounting to approximately 20% of the nation's total investment in science R&D. And the government has begun appropriate administrative reforms as well. For example, two

My current obsession

Using science and *Science* to create more coherence in the field of education

Bruce Alberts is Editor-in-Chief of *Science*.

EDITORIAL

Redefining Science Education

THERE IS A MAJOR MISMATCH BETWEEN OPPORTUNITY AND ACTION IN MOST EDUCATION SYSTEMS today. It revolves around what is meant by "science education," a term that is incorrectly defined in current usage. Rather than learning how to think scientifically, students are generally being told about science and asked to remember facts. This disturbing situation must be corrected if science education is to have any hope of taking its proper place as an essential part of the education of students everywhere.

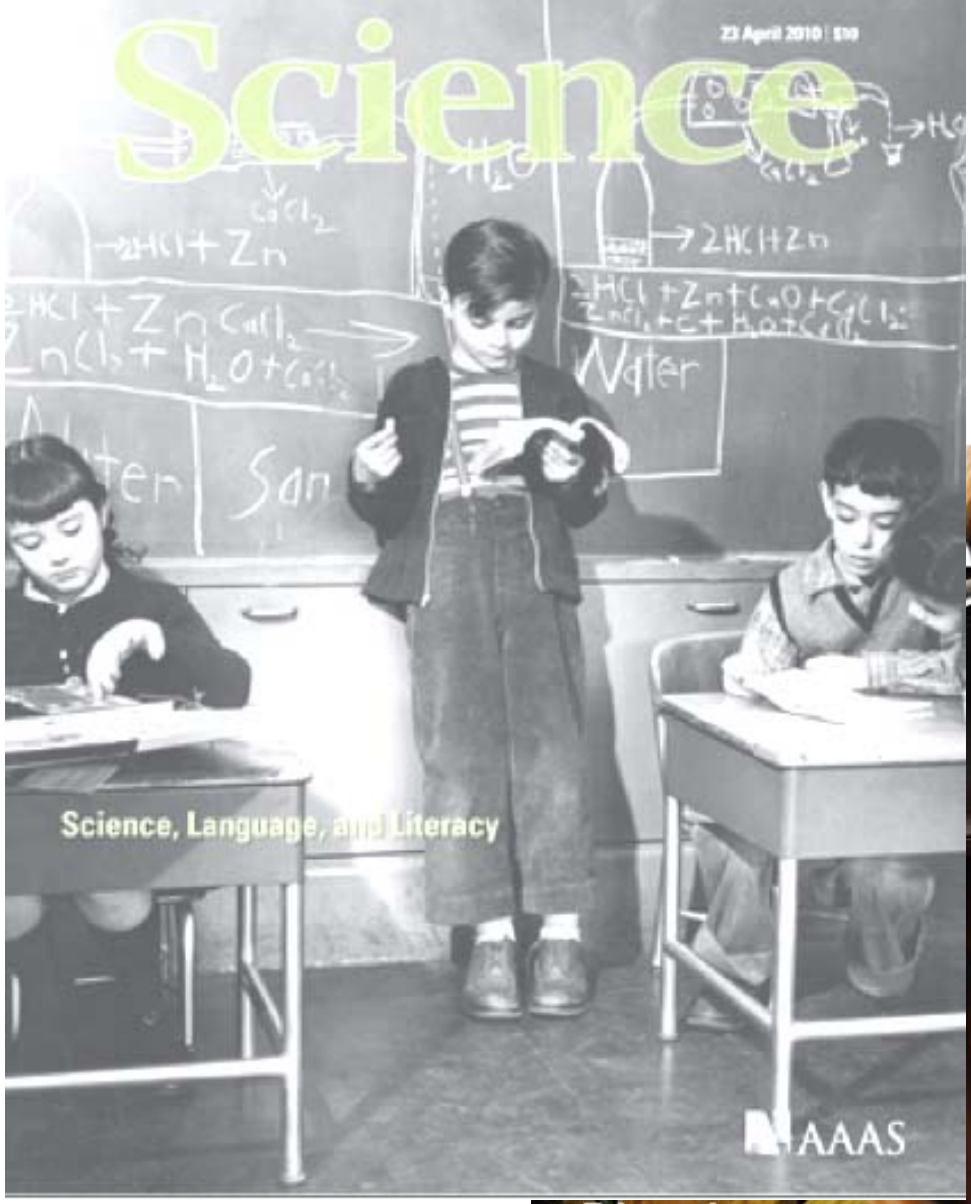
Scientists may tend to blame others for the problem, but—strange as it may seem—we have done more than anyone else to create it. Any objective analysis of a typical introductory science course taught today in colleges and universities around the world, whether it be biology, chemistry, physics, or earth sciences, would probably conclude that its purpose is to prepare students to "know, use, and interpret scientific explanations of the natural world" (strongly emphasizing the "know"). This is but one of four goals recommended for science education by the distinguished committee of scientists and science education experts convened by the U.S. National Academies that produced *Taking Science to School: Learning and Teaching Science in Grades K-8*. And yet college courses set the model for the teaching of science in earlier years.

The three other goals of equal merit and importance are to prepare students to generate and evaluate scientific evidence and explanations, to understand the nature and development of scientific knowledge, and to participate productively in scientific practices and discourse (summarized in the Academies' *Ready, Set, Science!*). Scientists would generally agree that all four types of science understanding are critical not only to a good science education but also to the basic education of everyone in the modern world. Why then do most science professors teach only the first one?

As the scientist and educator John A. Moore emphasized in his pro-

How Science magazine can help

2009 & 2010 special issues on education



How Science magazine can help

2011 special issue on education

Published in Sept 16th *Science*

NUCLEAR SAFETY

Preventing the Next Fukushima

Weak authority and largely voluntary standards limit global institutions' impact on nuclear safety and security.

Matthew Bunn* and Olli Heinonen

While this year's disaster at Japan's Fukushima Dai'ichi plant, the worst since Chernobyl in 1986, was caused by the one-two punch of a huge earthquake followed by an immense tsunami—a disaster unlikely to occur in many locations—it revealed technical and institutional weaknesses that must be fixed around the world. If nuclear power is to grow on the scale required to be a significant part of the solution to global climate disruption or scarcity of fossil fuels, major steps are needed to rebuild confidence that nuclear facilities will be safe from accidents and secure against attacks (*1*).

It is too soon to draw all the lessons from the Fukushima disaster. But it is clear that the reactors' abilities to maintain cooling in the event of a prolonged loss of power and to vent dangerous gas buildups were insufficient, as were the operators' ability to

IAEA. Will Fukushima lead to new action to strengthen the global nuclear safety and security system?

So far, the signs are not promising. With competing proposals from several countries, little understanding of which ideas would help, and a lack of sustained leadership focused on building support for key initiatives beforehand, little consensus emerged at June's IAEA ministerial meeting, although the ministers directed the agency to prepare a suggested action plan. That plan, a 22 September United Nations conference on nuclear safety and natural disasters; reviews of the CNS; and the ongoing WANO effort to find ways to strengthen its operations all represent opportunities for progress.

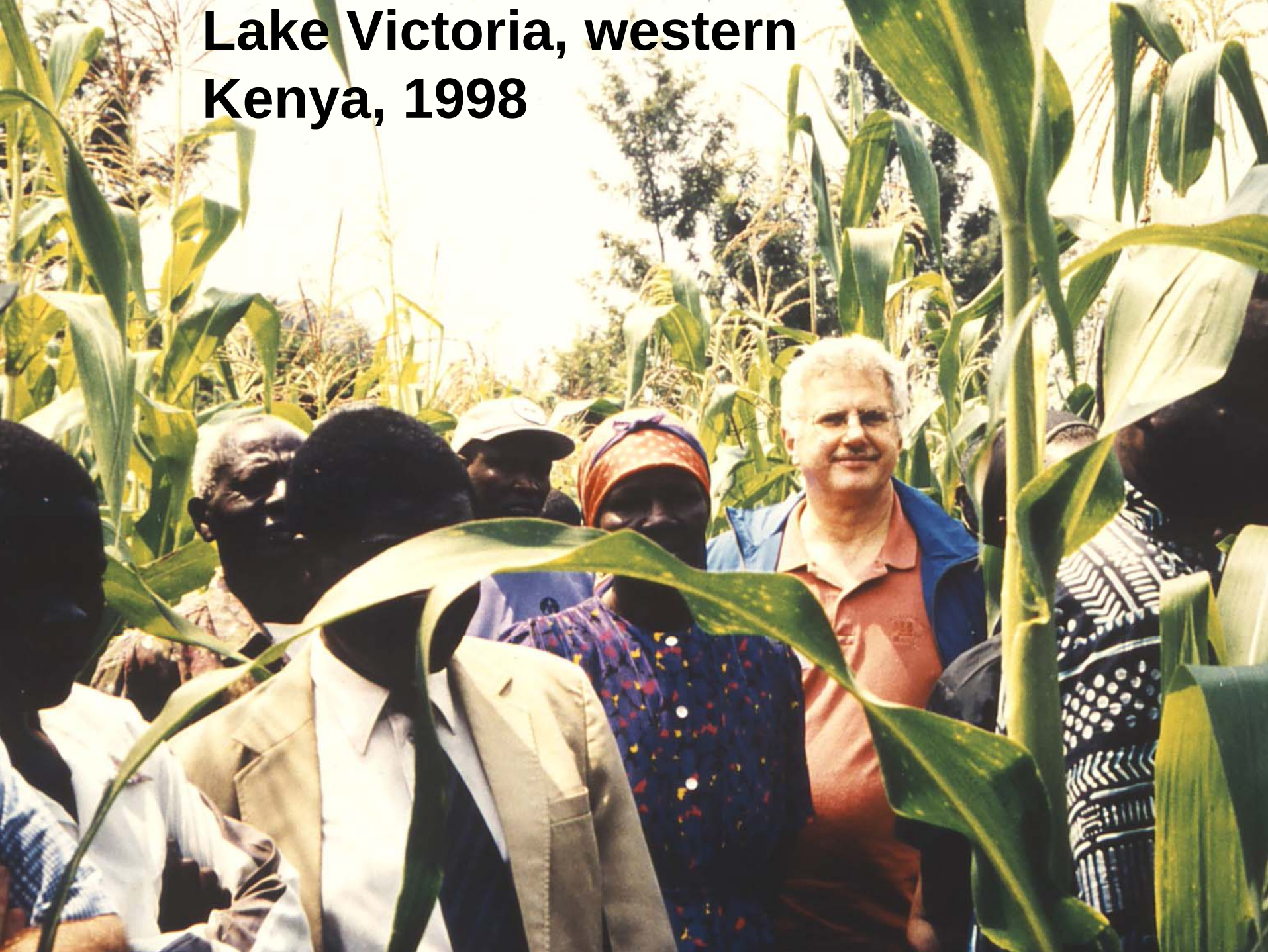
Over the long term, new reactor designs with greater reliance on "inherent" safety measures, e.g., not requiring active pumps and valves to maintain safe operation, may

Operators should be required to install filtered vents, as some countries have done, which could greatly reduce the amount of radiation released if a dangerous pressure buildup in a reactor forces operators to vent gases, as occurred at Fukushima (*4*). Operators should also be required to put in place measures to prevent spent fuel from melting or burning if a spent fuel pool drains, such as installing survivable systems to spray the fuel in the pool with water. Ultimately, much of the fuel now stored in spent fuel pools should be moved to safer dry casks (*5*).

Institutionally, regulators must be wholly independent of those they regulate and have the authority, resources, expertise, and culture to be effective. For example, Japan has decided to separate its regulator from the ministry responsible for nuclear power.

The IAEA should recommend that states require steps such as these. The United States

Another part of my education at the Academy: recognition of the critical importance of **Science for all** !


Lake Victoria, western
Kenya, 1998

What I learned

Science and technology can make a major difference for national development through many interventions. But most of these are much too fine-grained for outsiders to expect to be able to solve other nation's problems.

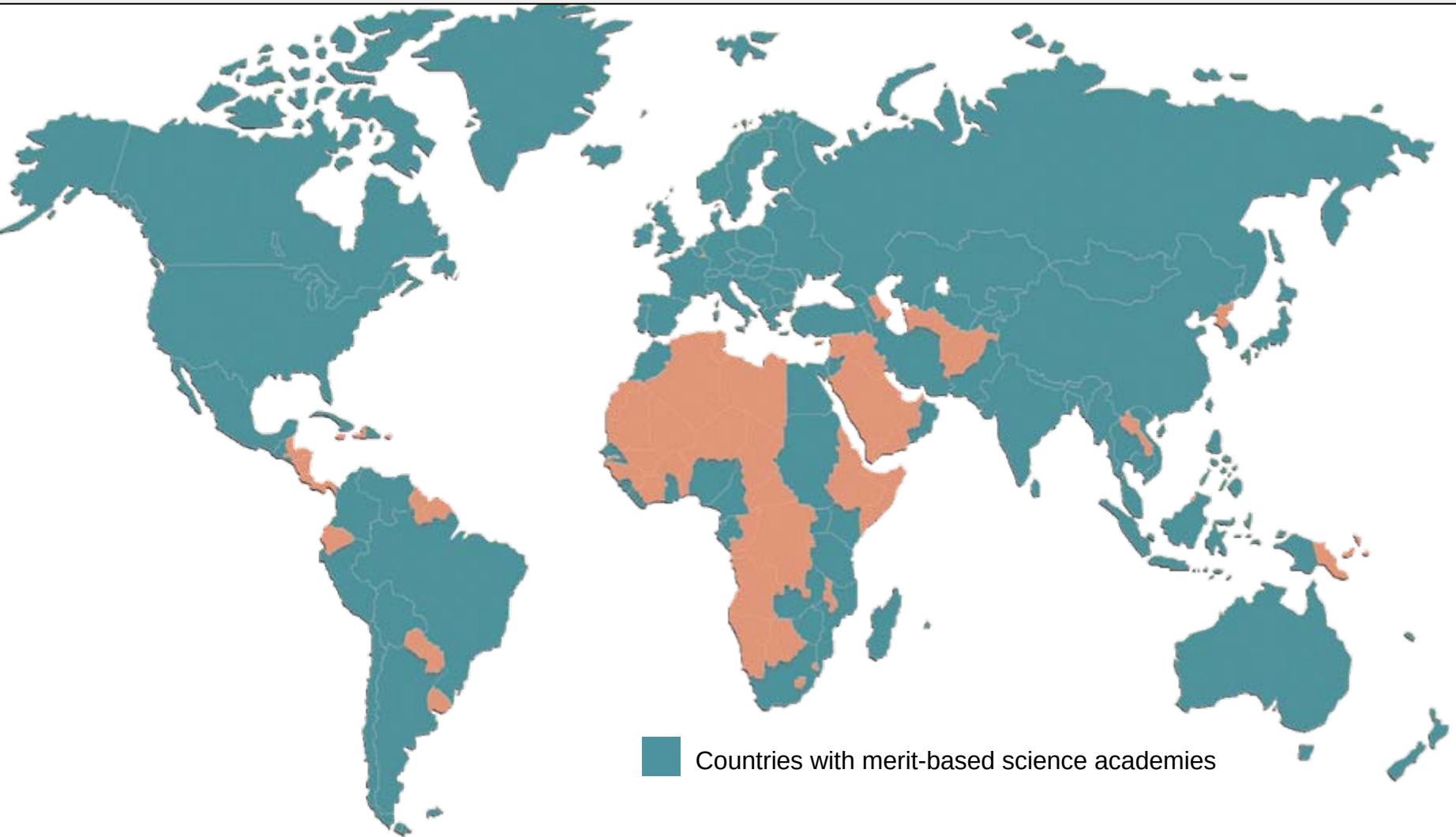
Instead, our focus should be on helping to build the local capacities that each nation will need to solve their problems themselves.

How do we spread a science throughout the world?

Scientists need to get organized!

The InterAcademy Panel on International Issues (**IAP**) is a network of 100 science academies

(Japan is represented by your **Science Council**)



The support of “sustainability science” by the InterAcademy Panel

- Helping the science academies in each nation develop a larger role in their own societies, including becoming a respected advisor to their own governments

- Sharing information and resources as “public goods” to strengthen world science (e.g., programs and resources for science education, ages 5 to 25)

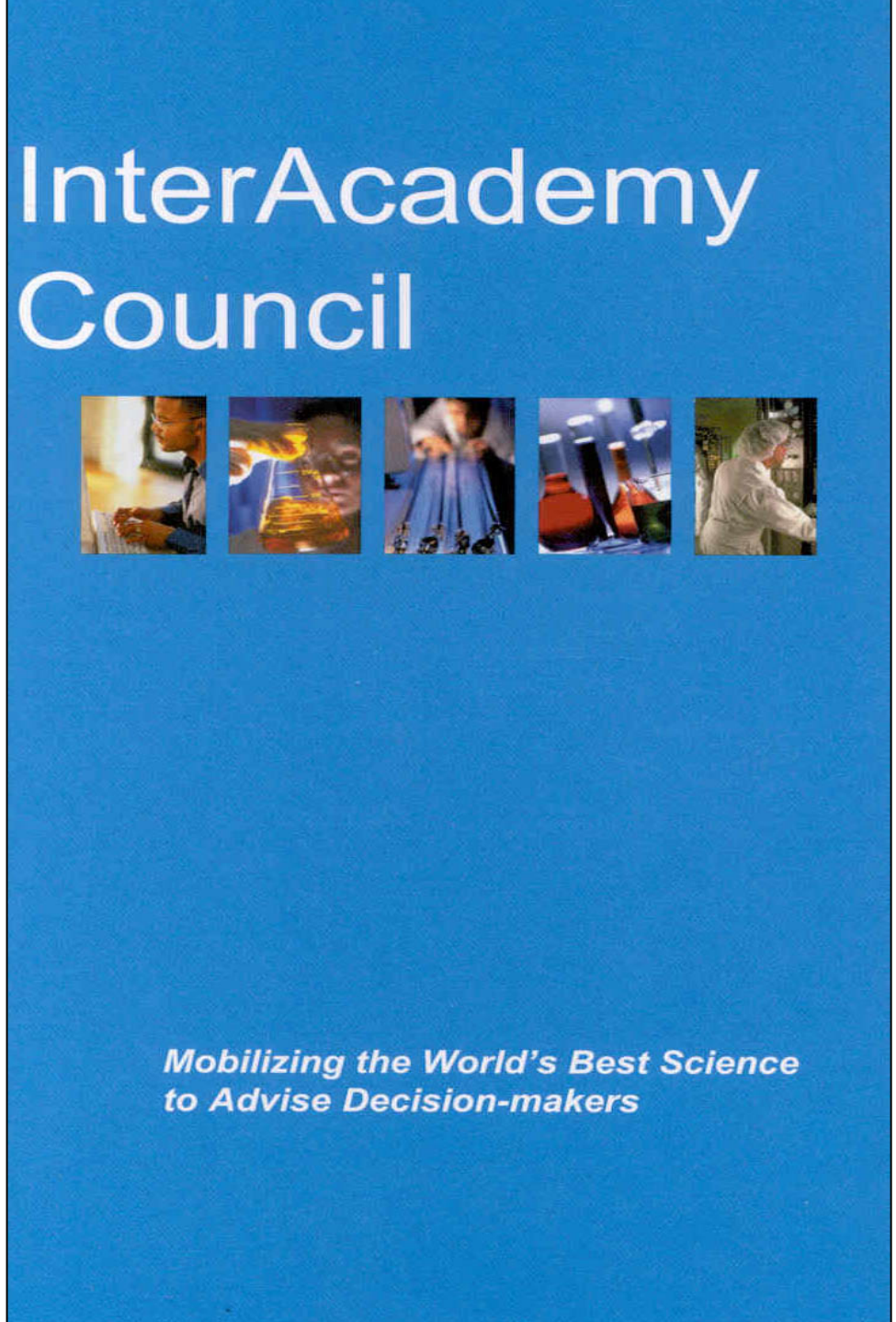
Through the IAP, the academy presidents recognized that scientists need to have a much larger presence in world affairs.

In particular, how can the world's scientists more effectively communicate their agreement on central issues?

The answer:

The IAC was established by the IAP in 2000, with a secretariat at KNAW in Amsterdam

Governed by 15 academy presidents

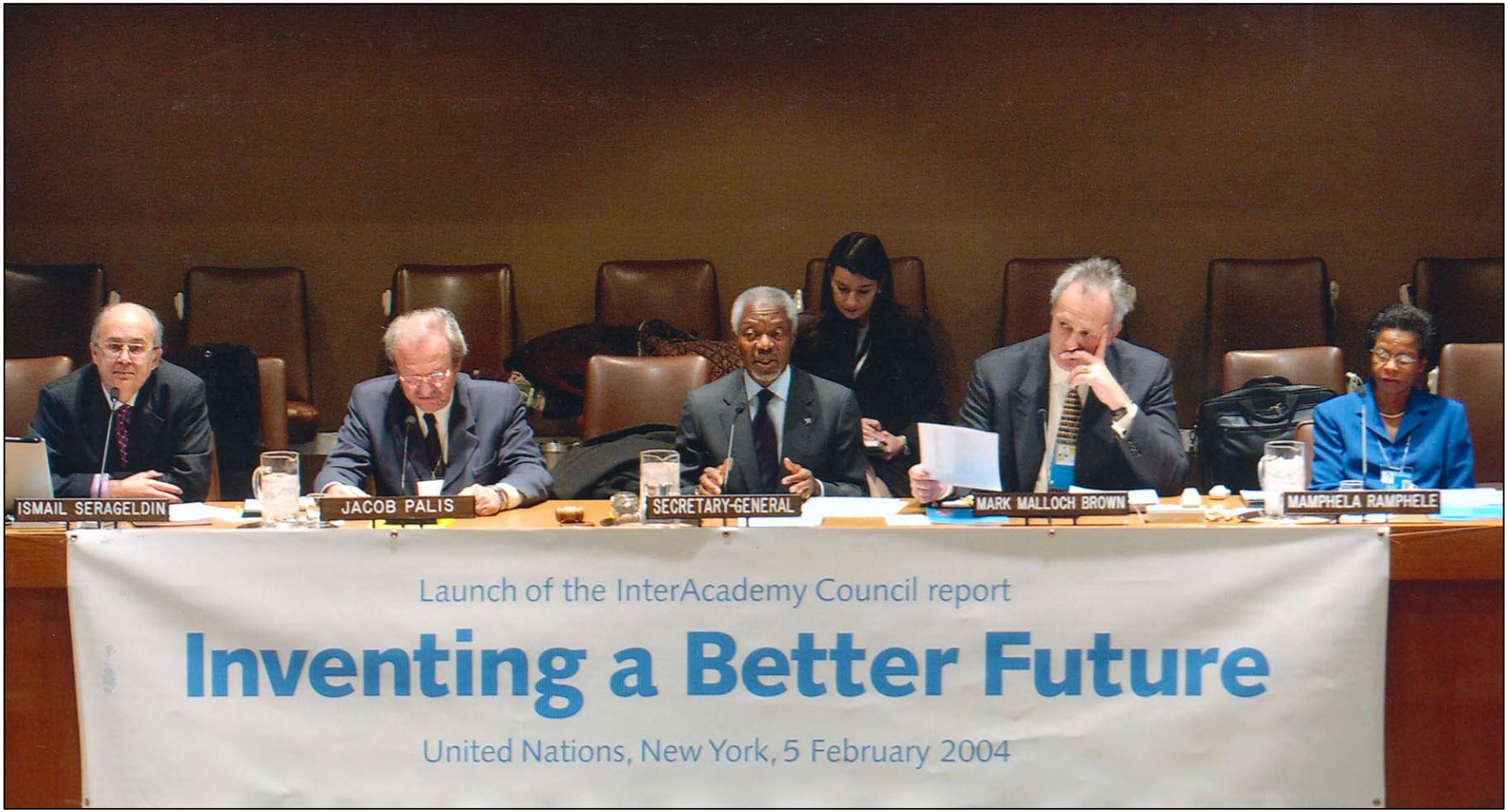


The first report of the InterAcademy Council was released at the UN General Assembly in February, 2004

Inventing a Better Future: A Strategy for Building Worldwide Capacities in Science and Technology.

- A guide for building high quality institutions for science and technology in every nation.
- Committee co-chairs from Brazil and Egypt, plus scientists from 10 other nations.


Inventing a Better Future


ISMAIL SERAGELDIN
JACOB PALIS
SECRETARY-GENERAL
MARK MALLOCH BROWN
MAMPHELA RAMPHELE
Launch of the InterAcademy Council report
Inventing a Better Future
United Nations, New York, 5 February 2004

Most recent IAC report on IPCC

The promise of world science collaboration

The promise of world science collaboration

InterAcademy Panel Young Scientists at the *World Economic Forum* in Tianjin, China

The formation of **Young Academies**

The urgent need for capacity building

- Those of us in more scientifically advanced nations must help less advanced nations develop a greater capacity in science and technology, as appropriate to their national needs.

- This in our own interest, as well as being critical for the rest of the world.

(I currently serve as President Obama's Science Envoy to Indonesia)

The First 3 Science Envoys

- Ahmed Zewail, Nobel Prize winner at Caltech (chemistry; born Egypt)

- Elias Zerhouni, former director of the US National Institutes of Health (radiology; born Algeria)

- Bruce Alberts, former President of the US National Academy of Sciences (cell biologist; born Chicago)

Volunteer position, with only expenses paid

The Challenges

- Design a role for Science Envoys that dramatically demonstrates the potential and effectiveness of science diplomacy.

- Create a Science Envoy “toolkit” and a set of principles to facilitate future efforts.

- Help the US Government create structures that optimally support the Science Envoy mission.

- **Can we convince skeptics that there should be similar science envoys to all major nations, in addition to those that are “Muslim-majority?**

President of the Indonesian Academy of Sciences, Sangkot Marzuki -- a molecular biologist

Annual **Frontiers of Science** workshop for future leaders of science in our two nations

Last month's workshop for science teachers

“Science knows no country..

Knowledge belongs to humanity..

It’s the torch that illuminates the world.”

Louis Pasteur