

The Future of

SCIENTIFIC ADVICE TO THE UNITED NATIONS

**A Summary Report to the Secretary-General
of the United Nations from the
SCIENTIFIC ADVISORY BOARD**

September 2016

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Scientific Advisory Board (SAB) Secretariat

UNESCO: Flavia Schlegel (Secretary), Salvatore Aricò (Coordinator), Isabelle Brugnon, Natasha Lazic, Ana Persic, Léo Trembley, Romeo Beccherelli (supported by the Consiglio Nazionale delle Ricerche – CNR), Fera Fizani (supported by the Malaysian Industry-Government Group for High Technology – MIGHT), Anna Zvereva (supported by the Russian Federation)

Drafting team

Susan Avery, Maria Ivanova and Robert L. Turner

Supported by the John W. McCormack Graduate School of Policy and Global Studies, University of Massachusetts Boston

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UN Photo/Albert González Farran: Helping a disabled child to solve a math problem

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Message from Scientific Advisory Board Chairperson Irina Bokova

The world is facing an array of new challenges that call for new ways of thinking to craft effective solutions that are to the benefit of all. In a world of increasing limits, we must nurture our greatest renewable energy – this is ingenuity and creativity. This is the importance of the sciences, which hold keys to answering many of the questions facing countries across the world today – questions about food security and water management, questions about ocean sustainability, questions about eradicating poverty, bolstering health, and forging new paths to inclusive, sustainable development. This is why the sciences are vital to leading forward the 2030 Agenda for Sustainable Development.

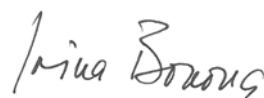
In this spirit, I was honoured to have been entrusted by the Secretary-General with the task to chair the Scientific Advisory Board. The distinguished members of the Scientific Advisory Board have worked tirelessly to explore and promote the centrality of science to the 2030 Agenda. Board members have pointed to inequalities which science can help to balance. They have emphasized the moral obligation to use science for the good, and highlighted the importance of the nexus between science and policy-making and the interdependence of the different disciplines and bodies of evidence.

The Scientific Advisory Board has provided advice to the Secretary-General in a timely, salient, and policy-relevant manner. Its work has coincided with ground-breaking times, when governments across the world are striving, with civil society, with private business, with the academic world, to

tackle the challenges of climate change and adapt to its consequences, to forge a renewed action agenda on disaster risk reduction, to craft a strategy for finance mobilization in support of sustainable development – all of this to take forward the 2030 Agenda for Sustainable Development.

This Report provides an analysis of priority issues and suggests recommendations on how to tackle them, with science at the heart of our action agenda. I believe that this is a powerful resource for the Secretary-General and the UN System as a whole, for stronger action at every level, from local to global.

I am deeply grateful to the Governments of Germany, Italy, Malaysia and the Russian Federation, along with all partner institutions, for their support to the meetings of the Board. I wish to acknowledge also the contributions of observers from the UN and other international organizations that have enriched the work of the Board. In closing, I wish to commend the distinguished members of the Board for sharing their visions, experience and commitment. Our thoughts go to the family and friends of Ahmed Zewail, who left us recently. He led key efforts to promote the contribution of science not only to the continuous quest of knowledge but also to building bridges between poor and rich countries. May this report be dedicated to his memory and his commitment to science.



Irina Bokova,
Chairperson of the Scientific Advisory Board

Scientific Advisory Board

Members



Tanya Abrahamse



Susan Avery



Sir Hilary McDonald Beckles



Ke Gong



Jörg Hinrich Hacker



Maria Ivanova



Hayat Sindi



Wole Boboyelo



Laurence Tubiana



Joji Cariño



Rosie Cooney



Abdallah S Daar



Eugenia Kalnay



Eva Kondorosi



Reiko Kuroda



Judi W. Wakhungu



Ada E. Yonath



Zakri Abdul Hamid



Gebisa Ejeta



Valdimir Fortov



Fabiola Gianotti



Dong-Pil Min



Carlos Nobre



Shankar Sastry



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(until November 2015)

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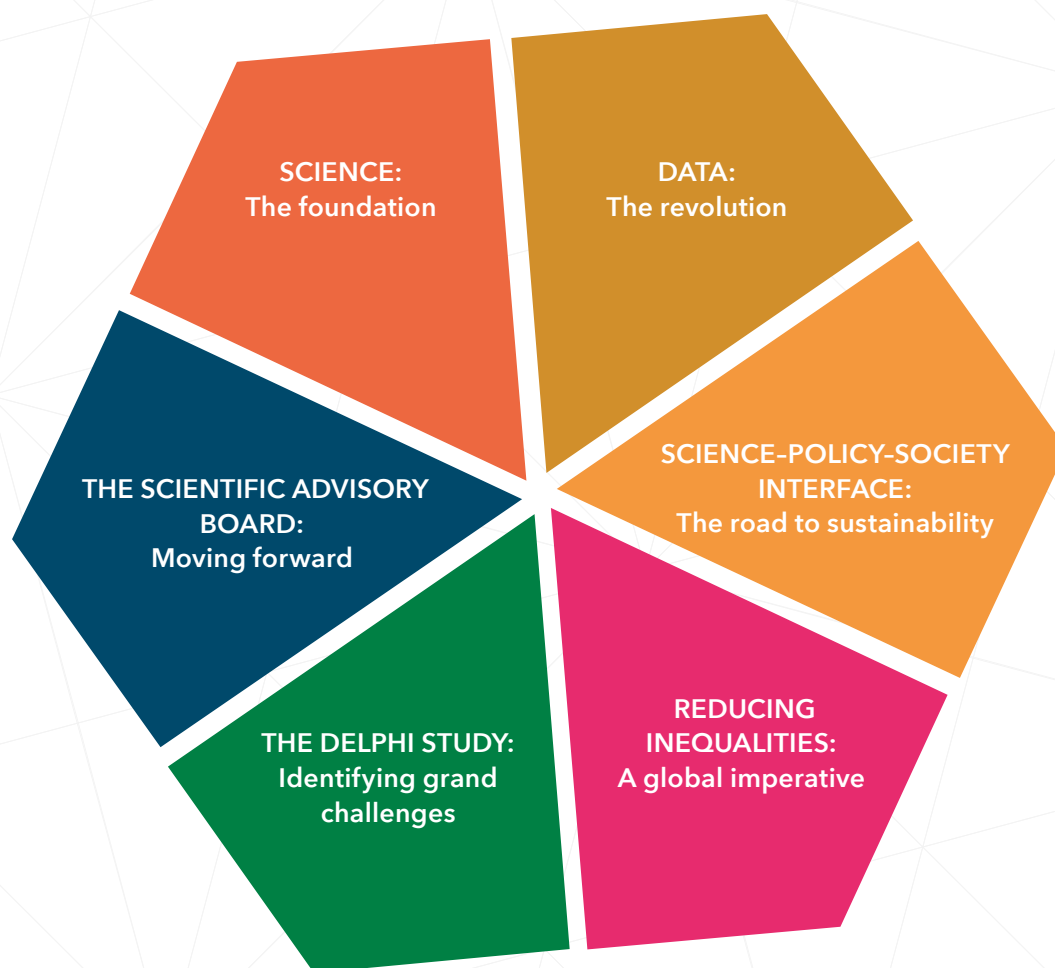


Irina Bokova

CONTENTS

Message: Scientific Advisory Board Chairperson Irina Bokova	3
Scientific Advisory Board: Members & Chairperson	4
EXECUTIVE SUMMARY	6
INTRODUCTION	8
SCIENCE: The foundation	11
Recommendations	13
DATA: The revolution	15
Recommendations	16
SCIENCE-POLICY-SOCIETY INTERFACE: The road to sustainability	17
Recommendations	20
REDUCING INEQUALITIES: A global imperative	22
Recommendations	23
THE DELPHI STUDY: Identifying grand challenges	24
Recommendations	24
THE SCIENTIFIC ADVISORY BOARD: Moving forward	27
Recommendations	28
CONCLUSION	31

EXECUTIVE SUMMARY



Humanity faces many challenges. Some are our own creations. Many require an international response. All must be met with policies that are clear, agreed-upon, and powerful. This is the reason that science is an essential component – in many cases the bedrock – of an effective strategy for policy and decision-making. Science makes policy out of brick, not straw.

The United Nations (UN) Scientific Advisory Board considers science central to decision-making for sustainable development. This report is grounded in that view. It summarizes the Board's work in specific areas, including the role of science; the data revolution; the interface of science, policy, and society; and efforts to reduce inequalities. It outlines the Delphi study identifying grand challenges. The report contains recommendations that could be taken up by the UN Secretary-General, by individual governments, by scientists, and by other stakeholders. It also features recommendations for the effective operation and future role of the UN Scientific Advisory Board itself.

Major findings and recommendations of the Board include

- 1.** Science is a public good, and deserves to be valued more highly, employed more widely, and used effectively by decision-makers at all levels.
- 2.** Science can be a game-changer in dealing with even the most pressing global challenges if it is used to its full potential at all three crucial phases: understanding the problems, formulating policies, and assuring that those policies are implemented effectively.
- 3.** Science should be integral – not an add-on – to all policy discussions. It should play a key role in the achievement of the 17 Sustainable Development Goals adopted by all UN member states in 2015.
- 4.** The burgeoning flow of scientific data – the data revolution – has great potential for good, if its availability, management, use, and growth are handled effectively.
- 5.** Basic research is the foundation for innovation; applied research creates products and technologies. All nations should embrace them both. Developing countries will increase their prospects for sustainable development if they fund research at a minimum of one percent of GDP. More advanced nations should invest three percent or more.
- 6.** To ensure a continuing flow of creative scientists, countries should strongly promote education in science, technology, engineering, and mathematics for all children beginning at an early age.
- 7.** Scientists, policy-makers, and society at large need to understand each other's perspectives; they by nature operate from different priorities and are subject to different forms of accountability. They should therefore jointly contribute to an enhanced science-policy-society interface.
- 8.** Science can help narrow economic and opportunity gaps. Bringing together science with indigenous and local knowledge will be critical for providing the most appropriate solutions for sustainable development, particularly when it comes to implementing the Sustainable Development Goals at the local level.
- 9.** Science has value beyond issues that are essentially "scientific." When tensions arise among nations, their leaders can respond far better if they understand and agree upon the scientific evidence for the root causes of those tensions.
- 10.** In addressing the world's grand challenges, the United Nations should promote greater global collaboration, encourage the use of international science networks, and provide avenues for science to inform and implement policies.

INTRODUCTION

*Science is vital to
advance sustainable
development,
reduce inequality
and eradicate
extreme poverty.*

In the opening ceremony launching the UN Scientific Advisory Board in January 2014, UN Secretary-General Ban Ki-moon stressed the importance of science “to advance sustainable development, reduce inequality and eradicate extreme poverty.”

Created on the recommendation of the UN High-level Panel on Global Sustainability in its 2012 report *Resilient People, Resilient Planet: A future worth choosing*, the UN Scientific Advisory Board is unique. It is the only science board to

operate at such a high level of international governance, and with a mandate to provide advice on a broad array of the most pressing challenges for the planet and its people in the era of the Anthropocene, when humanity has become a planetary force.

The High-Level Panel's report urged that “Governments and the scientific community should take practical steps, including through the launching of a major global scientific initiative, to strengthen the interface between policy and science.” To that end, the report said “the Secretary-General should consider naming a chief scientific advisor or establishing a scientific advisory board with diverse knowledge and experience to advise him or her and other organs of the United Nations.” Secretary-General Ban Ki-moon in September 2013 established the Scientific Advisory Board (the Board) by appointing its 26 members (13 women and 13 men) from a broad range of fields and disciplines. Much of the work of this diverse Board has indeed been pioneering, as anticipated by the process that created it.

DUK-photothek



UN Secretary-General Ban Ki-moon and the UN Scientific Advisory Board at the Opening Ceremony in Berlin, Germany, 30–31 January 2014

From its inception, the Board had the following mandate:

The central function of the Board will be to provide advice on science, technology and innovation (STI) for sustainable development to the UN Secretary-General and to executive heads of UN organizations. The Board will bring together in a coherent manner the collective capacity of all relevant scientific fields, with due regard to social and ethical dimensions of sustainable development. The fields will span a broad spectrum, from the basic sciences, through engineering and technology, social science and humanities, ethics, health, economic, behavioral, and agricultural sciences, in addition to the environmental sciences, which are more commonly associated with sustainability.

MEETINGS & DATES

1. **Berlin, Germany**
30–31 January 2014
2. **Paris, France**
10–11 December 2014
3. **Kuala Lumpur, Malaysia**
26–27 May 2015
4. **St. Petersburg, Russian Federation**
14–15 December 2015
5. **Trieste, Italy**
24–25 May 2016

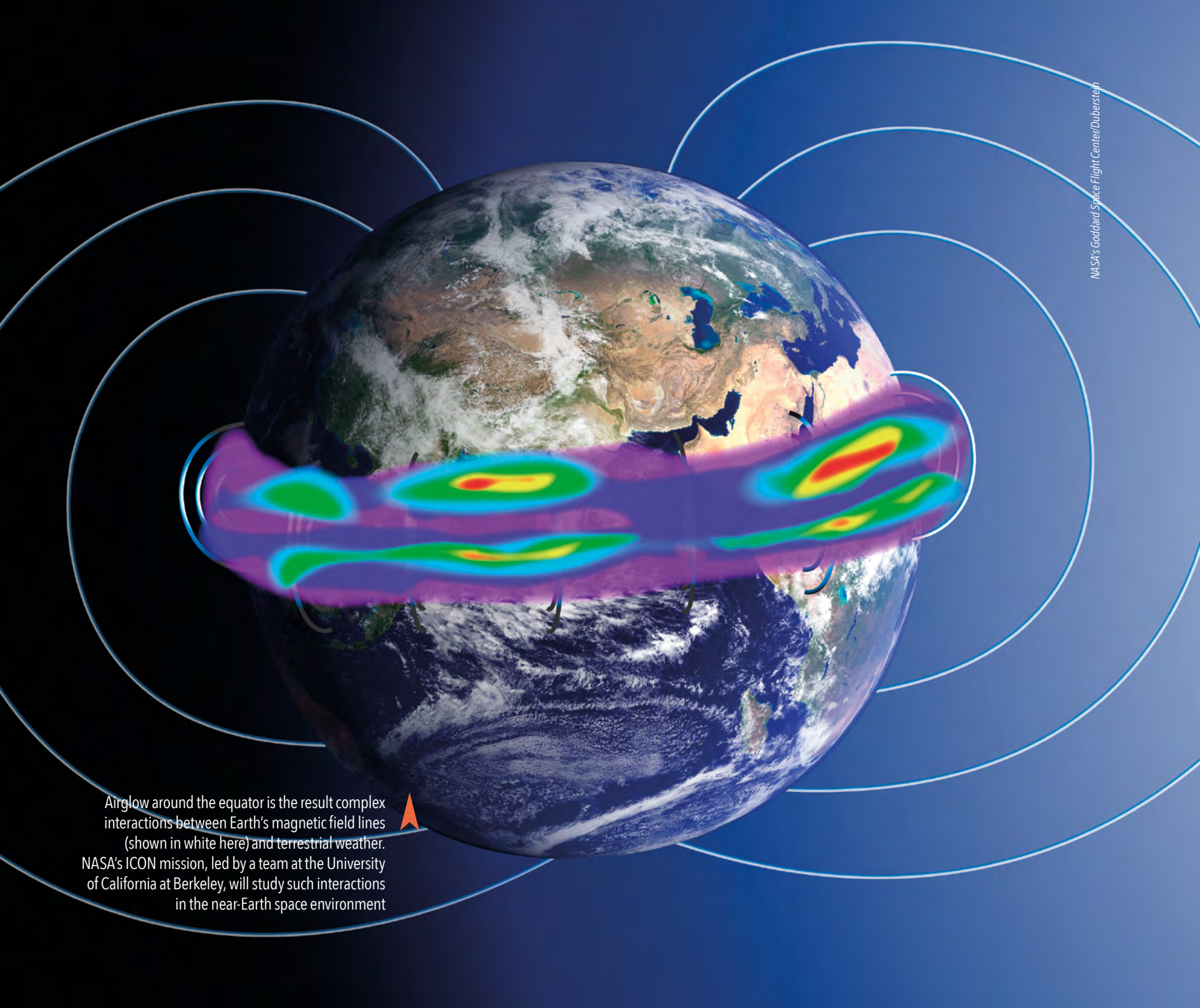
The Board has met five times, most recently in May 2016, in Trieste, Italy.

The Board has produced twelve policy briefs and other papers, focusing on issues ranging from the data revolution and the role of science in achieving sustainable development goals to the ambitious Delphi study which seeks to identify major "scientific concerns about the future of people and the planet" as requested by the Secretary-General.

Nearly a dozen subgroups of the Board have been formed and worked on specific issues and tasks. This Summary Report is drawn largely from the policy briefs and other advice requested by the Secretary-General, or generated by the Board on its own initiative. The Scientific Advisory Board hopes and believes it has provided and is providing valuable service to the Secretary-General, to the United Nations, and to the world community.

Given the number and complexity of global challenges today, the Board recommends that the Secretary-General retain this institutional innovation in the United Nations, and strengthen its role and its collaborations with other UN organizations.



The image features a central view of Earth from space, showing the Americas and parts of Europe and Africa. Overlaid on the Earth are white, curved lines representing magnetic field lines that loop around the planet. A horizontal band of vibrant colors—purple, blue, green, yellow, and red—wraps around the equator, representing the aurora borealis and australis. The background is a deep blue gradient.

Airglow around the equator is the result complex interactions between Earth's magnetic field lines (shown in white here) and terrestrial weather. NASA's ICON mission, led by a team at the University of California at Berkeley, will study such interactions in the near-Earth space environment

SCIENCE: The foundation

Science, technology, and innovation are the key drivers of a development agenda that is people-centered and sustainable. STI can be a game-changer in dealing with nearly all the most pressing global challenges. Solutions based in STI can contribute significantly to alleviating poverty, creating jobs, reducing inequalities, increasing incomes, and enhancing health and well-being. STI can help provide food and water security and access to energy, and is central to the response to climate change and biodiversity loss.

More broadly, as nations work toward the Sustainable Development Goals (SDGs), science will be an indispensable ally, exploring the true nature of complex problems, and pointing ways toward the most effective responses.

Science demonstrates its enormous value every day, yet much more needs to be accomplished. For instance, scientists have tirelessly worked on increasing our understanding of the causes and impacts of climate change. This research has required new observations of the atmosphere, ocean, land, and ice as well as new integrated models. It has pulled together the research communities across disciplines of geoscience, engineering, and social science in order to address scientific questions at a system level and has served as the foundation for the Intergovernmental Panel on Climate Change and other initiatives. Such

knowledge is critical in determining how our future as the human race in a sustainable environment will unfold. Solutions are being proposed and tested. As one example, scientists and engineers have advanced the efficiency of solar panels and wind turbines, and the capacity and durability of batteries, much faster than many predicted, raising hope where there was once pessimism, that the world may be able to reduce its dependence on fossil fuels before it is too late.

The people responding to these challenges – from heads of state and government, to ministers, resource managers, farmers and technicians – are often frustrated to find that the facts on the ground are changing rapidly, and that the change is accelerating, sometimes exponentially. This rapid change is a loud alarm bell, signaling the urgent need for science to keep pace. Climate change is just one global challenge for which this need for a further massive increase in the efficacy of the science is clear. There are many such challenges including the spread of infectious diseases, the precipitous decline in global biodiversity, population growth, rich-poor gaps that are widening instead of narrowing, and the degradation of the world's ocean. In many cases, greater efficacy may not require massive new funding. Research being conducted by universities, private companies, and governments can be extraordinarily valuable, and lead to groundbreaking social innovation, especially if the results are harnessed effectively.

In addition, there is no doubt that important knowledge already exists among indigenous peoples and local communities all over the globe, waiting to be integrated and promoted by a larger audience. History provides many examples of this reality. One familiar illustration: How many thousands of Europeans died of malaria, or suffered blood-letting or limb amputations, before society finally recognized that preparations from the bark of the Cinchona tree (now known to contain quinine) used for centuries by the Quechua people of Peru, Bolivia, and Ecuador actually cured the disease, often completely?

Applied science in many forms has value that is universally accepted, as has been abundantly demonstrated, for instance, in the success of medical researchers to develop the Ebola vaccine quickly. Yet in many quarters science is still not fully embraced as a prerequisite to effective policy-making.

Meanwhile, basic research conducted with no specific application in mind – or curiosity-driven research – has often produced breakthroughs. Even though it may not provide immediate solutions, basic science leads to new discoveries and new knowledge, and offers new approaches, and is the fuel for new technologies and innovation.

Basic science and applied science are interconnected and interdependent. They

complement each other so as to provide innovative solutions to the challenges humanity faces on the way to sustainable development. Science of both types needs to be recognized as a public good, integral to achieving our common goals.

Scientific knowledge often takes years to work into policy development as was demonstrated in December 2015, when, at the 21st Conference of the Parties of the UN Framework Convention on Climate Change (COP21), 195 nations adopted the Paris Agreement on Climate Change – a full quarter-century after the global scientific community met in Geneva to tell the world that climate change was indeed a significant threat, and largely caused by humans. The science was necessary, but not sufficient. A great deal of advocacy and deliberation over many years was needed before the Paris Agreement was reached.

A dozen countries¹ with strong STI systems invest over 2.5 percent of their gross domestic product in research and development, while some poorer countries view a one percent investment as a high target. Still, many countries fail to invest their share to fund an acceptable level of basic research. Developing nations often underfund any but the most applied research, perhaps understandably, but threatening thereby to widen the income gap with richer nations even further. The United Nations, through its Scientific Advisory Board,

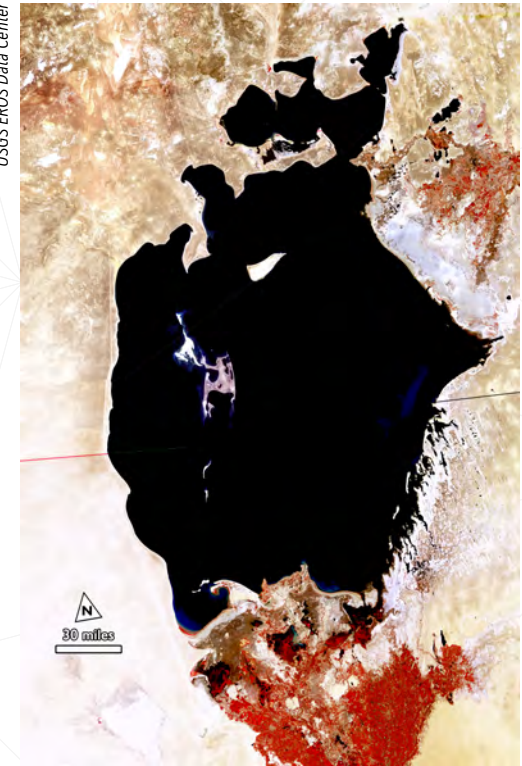
¹ In 2014, these countries were: Israel 4.2%, South Korea 3.6%, Finland 3.5%, Sweden 3.4%, Japan 3.4%, Germany 2.9%, Switzerland 2.9%, Denmark 2.9%, United States 2.8%, Austria 2.8%, Singapore 2.7%, Qatar 2.7%. See 2014 *Global R&D Funding Forecast*, Battelle.

should push for and facilitate the establishment of international goals for research funding, both applied and curiosity-driven, and urge individual nations to achieve them.

Science should at all times proceed with independence, diligence, and prudence. It is critical that the deliberative scientific process is followed and protected and that data and scientific results are readily available. Scientific credibility is built upon rigor and reproducibility. Individual results taken out of broader scientific context can seem to be contradictory and not useful for policy decisions. For science to be effective in informing policy it must reflect the best aggregated knowledge available and be communicated clearly.

Science has value beyond its immediate subject matter. For instance, international tensions are far more likely to be relieved when negotiations are based on evidence and facts, rather than preconceptions or beliefs. And science can be an equalizer, an enabler of all people, especially the most marginalized and vulnerable. Among many examples: advances in food science that have improved the nutrition of hundreds of millions of people, and development of vaccines that have eradicated smallpox and nearly eradicated other diseases such as polio. Today, HIV infection is not the death sentence it was only a few years ago, thanks to new antiretroviral drugs that are now available throughout the world. Science is certain to play a major role in confronting such global challenges in the future.

USGS EROS Data Center

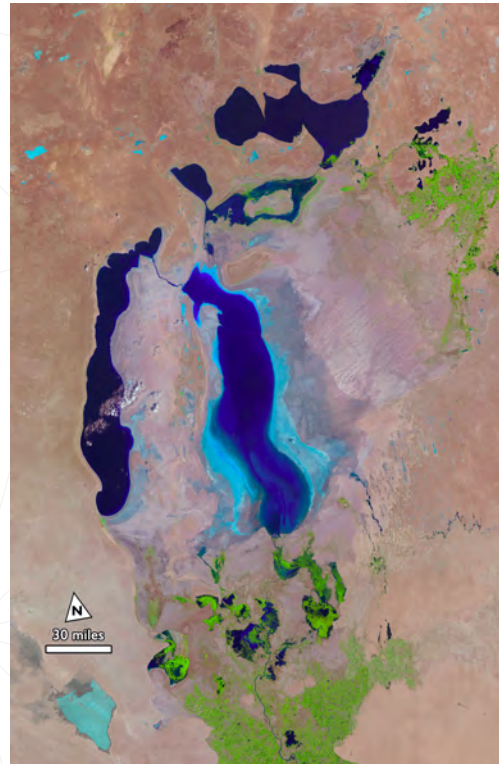


▲ The Aral Sea in Central Asia began disappearing in the 1960s because of the diversion of its two feeder rivers for agriculture
Left to right: 1977, 1998 and 2010

Basic science and applied science are interconnected and interdependent.



Science is critical to discovering the detailed nature of multifaceted challenges, and to formulating the policies that will respond to them most powerfully. Science is also fundamental to measuring outcomes, establishing causality and encouraging the deployment of the most effective possible strategies. In a word, implementation of those strategies is crucial, and the implementers must work hand-in-hand with the scientists.



No one thinks the United Nations can or should provide solutions to all the world's great challenges, or even be the leader in each of those quests. But the world surely has a right to expect and even demand that the United Nations deliver what no other institution can: setting global priorities, promoting and coordinating research and action to address the most challenging problems, enabling the effective worldwide use of all data – in effect, building policies with bricks.

RECOMMENDATIONS

- 1.** Scientists, policy-makers, and societal leaders should strongly advocate for public awareness of science as a public good and for public understanding of scientific knowledge and methods. The United Nations should take leadership of this campaign.
- 2.** Scientific research – both basic and applied – deserves greater support from all nations. Even the poorest countries should invest a minimum of one percent of gross domestic product in research, and more advanced nations should invest three percent or more.
- 3.** At every step, scientists must be vigilant in assuring that they are narrowing, and not widening, income and opportunity gaps.
- 4.** It is critical that needed policies be implemented effectively. To that end, the implementers need to use science to the utmost, to determine if their actions are producing the desired results.
- 5.** Scientists also need to learn more about policy-making and implementation to engage more productively with the policy community.
- 6.** Training institutes for scientists and for policy-makers at all levels should be established, as one element of capacity building, both nationally and regionally.



Access to data: empowering women in Sudan

DATA: The revolution

The “Data Revolution”, the near-explosive growth in the volume of information, raises both opportunities and concerns in several areas:

- ▶ What is the quality of the data and how are they collected?
- ▶ How are they used?
- ▶ How can the world community deal with equity issues arising from differing abilities to access and make use of this fountain of information to transform it into useable robust knowledge?

The benefits, clearly, are enormous. Most broadly, the data enable us to look at the earth as an integrated system, encouraging scientists to use them in an integrated fashion. The approaches to the sharing of big data/information should draw from the rich experience acquired from techniques developed for the analysis and sharing of meteorological data and particle physics data, as well as the sharing of biodiversity, public health, and agricultural production data. These are exemplars of areas in which successful methods have been developed for the sharing of big data/information by multiple organizations across the world.

The Scientific Advisory Board urges an intense and steady focus on the quality of data, so that whenever possible the results establish causality and do not simply describe correlation. Such a

rigorous approach will be needed to ensure that the implementation of the SDGs is driven by the best available science, supported by data, with established cause and effect.

The rise of “big data” in particular opens new possibilities. Certainly the solid scientific underpinnings of the Paris Agreement relied heavily on an abundance of data. Some disciplines have more experience than others in dealing with such material, and offer models from which others can learn.

At the same time that data are rapidly becoming more plentiful and more useful, the Board has given priority as well to issues of equity. That focus has been strong and consistent. It is essential that the Data Revolution reduces, rather than entrenches, the data divide between rich and poor and men and women. Above all, this should be a revolution for equity in access and use of data.

But when it comes to equity, good intentions are only a start. To actually achieve a reduction in the data divide, the commitment will have to be unwavering, the efforts relentless.

There are steps to take, such as assuring that stakeholders from multiple perspectives are recruited to join in evaluating data and helping to plan how it will be used. Indeed, the United Nations, through its numerous agencies, is uniquely positioned to facilitate the collection

RECOMMENDATIONS

1. Data platforms should be harmonized and standardized to increase accessibility and encourage exchange.
2. International collaborations on data science and technology research are urgently required, especially to support countries with limited information, institutional, and technological capacity.
3. Adequate data infrastructure and policies should be created to deal with issues such as privacy, data access, data integrity, data preservation, and the control of the quality of data and repositories of data.
4. World leaders and the scientific community should encourage collectors of data, whether sovereign nations or other entities, to share it.
5. The United Nations should initiate a multidisciplinary international research project, including a diverse group of stakeholders, to examine how the highest-possible quality of data can be identified and developed for the implementation of the SDGs.
6. Since data collectors and providers frequently have little understanding of the cultures and needs of data users, and vice versa, a much stronger symbiosis between the two needs to be encouraged.

of various types of data with an eye to quality, equitable access and sharing, including privacy issues, and effective use.

Information meeting on Science for Sustainable Development: Scientific Advisory Board members and the President of the UNESCO Executive Board in Paris, December 2014

UNESCO



The Scientific Advisory Board urges an intense and steady focus on the quality of data, so that whenever possible the results establish causality and do not simply describe correlation.

SCIENCE-POLICY-SOCIETY INTERFACE: The road to sustainability

Climate change, population growth, and the deterioration of the world's ocean are all examples of global problems caused by multiple stressors, and which will require multiple solutions applied multiple times. As just one example, the ocean is not only threatened by temperature rise and the concomitant sea level rise, but also by changes in circulation, different patterns of mixing, acidification, deoxygenation, overfishing, pollution, and human litter.

Because of the complexity and scope of such problems, and because in some cases the dangers are not only increasing but accelerating, new approaches are needed.

In this context, much attention is paid to the "science-policy interface," and appropriately so. Science without policy can be scattered and often fruitless. Policy without science usually fails to accomplish the immediate goal, and undermines confidence that the next policy will be any better. When science and policy unite, the chances of success increase greatly.

Indeed, what is really needed is an efficient science-policy-society interface that will create and make use of a holistic framework

including a diversity of stakeholders, from government, civil society, indigenous peoples and local communities, businesses, academia, and research organizations. To be effective, cooperative effort of that breadth will need more than the occasional serendipitous interaction of different groups of society. It will need an institutionalized architecture that convenes all affected parties to assure that scientific knowledge is utilized fully so that policy-making is evidence-based.

The United Nations possesses the unmatched ability to provide this architecture, and is doing so now in many ways and at many levels. Yet the architecture needs to be improved substantially. Frequently, science provides compelling evidence of serious and irreversible threats to the environment and to human well-being posed by particular courses of action, yet these actions are pursued nonetheless. Indeed, decisions are often taken in response to short-term economic and political interests, rather than the long-term interests of people and the planet. So there is a need for wider recognition of science as a public good – one which, by its nature, takes the long view. Once achieved, this recognition would warn public officials and other societal leaders to ignore scientific evidence at their peril.

No other organization rivals the United Nations in its ability to nurture the connections of science, policy and society that are so urgently needed now, and to do so with a global purview. Who else, for instance, would pull together a group of world leaders into a High-Level Political Forum in an effort to strengthen these connections? For the science-policy-society interface to be effective, it is critical for science to be drawn into the decision-making process more systematically, for science to take on current social problems, and for science to be communicated effectively to political leaders and the larger society. The UN High-Level Political Forum encourages this process, and its role deserves to be reinforced.

When considering the science-policy-society interface, it is important to remember that scientists and decision-makers by nature operate from different priorities, and are subject to different forms of accountability. The arrow of influence points in both directions. Yes, policy-makers often respond to short-term dictates that pay too little attention to the more fundamental, long-term view set out by science. But it is also true that many scientists focus on research and publishing peer-reviewed papers, and are not familiar with the complexities and practical



Secretary-General Ban Ki-moon at the World Economic Forum launch of the Sustainable Development Goals, in January 2016



UN Photo/Dwi Kristiyadi

problems associated with policy-making and implementation. The United Nations can and should take steps to encourage mutual understanding, and thereby to make the interface more fruitful.

The “society” part of this interface includes “politics,” in the sense that the people, through political consensus, are the ones to assess science-informed policy options and carry out the chosen strategies. And it also includes private businesses, non-governmental organizations, and other stakeholders. Scientific inputs are critical to our understanding of the drivers of global change and of its multi-faceted, complex impacts. These are also fundamental to the legitimacy of efforts to control the problem and to the creation of a growing slate of available and affordable solutions.

Adequate funding for research that is policy-relevant can produce formidable scientific results that can lead in turn to policy initiatives of global societal and environmental importance.

Decision-making frameworks must be developed that lead policy-makers toward the right decisions; this will require full use of the best science available, and often the generation of new science. And just as one policy will not suffice to tackle any such multiple stressor issue, one policy-maker will not do, either. People from different backgrounds, different cultures, and different disciplines will have to come together in those frameworks to produce the best decisions. In most instances, repeated interactions will be essential to optimal outcomes.

This does not mean that all actions will be reduced to an average. The independent-minded scientist or policy-maker or advocate who clings passionately to a divergent belief must have the courage to speak out, and, where there is merit, decision-makers must listen, and have the courage to be persuaded. But even when such individuals produce real breakthroughs, the next steps will be taken collegially. Increasingly, leadership will mean interaction – the sharing of information and policymaking – the sharing of power.

Keys to success will be the science, and how it is communicated. It is critical for science to be engaged in the decision-making process more systematically, synthesized in ways that are relevant to current societal problems and challenges, and communicated to political

leaders and societal groups in ways that are accessible and comprehensible.

Another critical need is the design and implementation of systematic monitoring and evaluation systems to gauge progress toward the attainment of the SDGs and their related targets. Evidence-based implementation and monitoring will be crucial to understanding successes and failures.

Information is indeed power, and effective communication is urgently needed if the world community is to be engaged in decision-making. This means not only better communication within the scientific community, or among policy-makers, or between politicians and citizens, but among all those with a stake in the outcomes.



So there is a need for wider recognition of science as a public good – one which, by its nature, takes the long view.

◀ Members of the Scientific Advisory Board in discussion at the 3rd meeting, Malaysia, May 2015

MIGHT



RECOMMENDATIONS

- 1.** Existing bodies such as the national academies of science and the UN Scientific Advisory Board should engage more systematically in reviewing existing programmes and in preparing new initiatives, thus laying the ground for scientifically informed policy-making.
- 2.** Science needs to be adequately represented in the emerging implementation and review architecture of the 2030 Agenda within the United Nations, especially with regard to the High-Level Political Forum for Sustainable Development; the Global Sustainable Development Report; the Technology Facilitation Mechanism and its Science, Technology and Innovation Forum for the Sustainable Development Goals.
- 3.** The United Nations should strengthen the High-Level Political Forum, and its use of science, through convening regular scientific conferences in advance of HLPF sessions and through representation of the Scientific Advisory Board as an advisor, or preferably as a sitting member.
- 4.** The United Nations should make greater use of its Global Sustainable Development Report by elevating it to the level of a flagship global publication, engaging the scientific community in its production, and ensuring that it focuses on major challenges and contains offerings from a broad range of scientific bodies.
- 5.** Decision-makers who would benefit from scientific knowledge should make science an integral part of their design from the start.
- 6.** Transparency is a must, both to make the scientific expertise more objective, and also to minimize the influence of special interests. A relationship that would be an outright conflict of interest when kept secret might turn into a valuable confluence of interests if everyone understands what those interests are.
- 7.** To ensure a continuing flow of creative scientists with the skills and training that will be needed as technology becomes ever more complex, countries should promote science, technology, engineering, and mathematics in their schools.



UN Photo/JC McIlwaine



A woman educates about the polio vaccination campaign in Darfur, Sudan

REDUCING INEQUALITIES:

A global imperative

Since the Scientific Advisory Board's inception, helping the United Nations to reduce inequalities has been a core goal. There has been progress, particularly among the most vulnerable nations, many of which have improved their standing compared with more developed countries. But by several measures, economic and opportunity gaps within poor nations are widening. In developing countries, income inequality rose by 11 percent between 1990 and 2010. According to a recent (June, 2016) UNICEF report, children born in sub-Saharan Africa are 12 times more likely than children in high-income countries to die before their fifth birthday, just as they were in 1990.

Large disparities persist in access to health care, to education that is effective enough to lift children out of poverty, and to other assets.

Indeed, "Reduced Inequalities" is one of 17 SDGs for 2030, but is closely linked to many others, such as eradicating poverty and hunger. Still, nearly 1 billion people live in extreme poverty, and 800 million are malnourished.

Clearly, these goals must be pursued holistically; the income gap will not shrink significantly until the opportunity gap closes; quality education cannot be delivered in classrooms full of ill or hungry children.

Strategic investments in science, technology, and innovation should focus on sustainable solutions that are co-designed and co-owned by all. This strategy should include investments in science education; novel alternative energy solutions; new robust building materials from locally available materials; nanotechnology for health and agriculture; and biological approaches

to industrial production, environmental remediation, and management. The focus should be on inclusive approaches centered on knowledge of all types that have withstood the test of time.

This last point is crucial. If efforts to reduce disparities employ a top-down approach that assumes that larger and richer countries have all the right answers, this can contribute to the homogenizing effects of globalization. But this is emphatically a two-way street. There are many ways in which knowledge produced in developing countries can be used to solve problems in developed countries. The knowledge required for addressing the complex problems of the 21st century will need to include the vital contribution of indigenous and local peoples and the experimental evidence they generate.

Examples abound: The devastating Indian Ocean tsunami of 2004 took some 200,000 lives, but the Moken peoples of the Surin Islands in Thailand remained unharmed. Though none had experienced a tsunami, they knew the signs – knowledge passed down through generations – telling them to move swiftly to higher ground. A different example:

The focus should be on inclusive approaches centered on knowledge of all types that have withstood the test of time.

the often-controversial shifting or swidden agriculture, involving the rotational clearing and sometimes burning of plots, is opposed by large-scale producers. However, in many of the tropical forests of Asia, Latin America, and Africa, through better management of land use pressures and respect for customary tenures, full rotation could enhance productivity and sustain biodiversity.

Gender inequality is another persistent disparity. Women make up half the world's population, but they do not play a significant role in the world's policy-making. Candidly, most

fields of science have long been dominated by male voices. Greater gender balance can only produce better analysis and better policy-making. The Scientific Advisory Board believes that its own make-up – intentionally half men and half women – has fostered vigorous debate and healthy collaboration, with results that are likely more comprehensive and constructive than would be the case otherwise.

The best policies, responding even to society's largest problems, will likely emerge when all – men and women, rich and poor – are at the table, interacting.

RECOMMENDATIONS

- 1.** The United Nations should adopt and encourage robust, holistic policies that recognize the forces linking such factors as health, education, opportunity, incomes, social mobility, and nutrition.
- 2.** Science education deserves special attention because it lags badly in many less-developed countries, and also because persons well trained in science would improve not only their own families' incomes and prospects, but those of their nations as well.
- 3.** The United Nations should consider establishing centers of excellence in developing countries, with high schools and colleges around them, as preparation for the next generation of scientists.
- 4.** At every turn, women should have the opportunity to engage fully – not in the interest of equality alone, but in the interest of the best outcomes.
- 5.** In this sustainable development era, science should incorporate all valuable inputs, including from indigenous and local knowledge systems.

◀ Children conduct classroom science experiment in Harar, Ethiopia

UN Photo/Marco Dormino



THE DELPHI STUDY:

Identifying grand challenges

One key asset of the UN Scientific Advisory Board is its ability to take a global perspective. This allowed the Board to make a fresh assessment of some of the most pressing global challenges. Eight grand challenges emerged in May 2015 from a Delphi study² initiated the year before in which the UN Secretary-General, Ban Ki-moon, invited the Board to identify “scientific concerns about the future of people and the planet.”

These issues are addressed in detail in the Delphi study on the Top Challenges for the Future of Humanity and the Planet (SAB/4/INF/7).³

Immediately clear from the list of grand challenges is that these cannot be categorized as “scientific concerns” alone, but as serious problems for the entire world community. The Board’s Delphi study could therefore help prioritize actionable ideas of use in pursuit of the SDGs, and could also stimulate long-range thinking about the

development and implementation of policies needed to respond to global challenges.

Science itself cannot be categorized as a special interest or even as a useful tool, but must be seen as integral to any serious consideration of the challenges we face, the powerful policies that will be needed to surmount them, and the development of adaptation and mitigation strategies and technologies.

RECOMMENDATIONS

- 1.** The United Nations should seek a broader audience for the Delphi study findings through active outreach, moving them from science to policy and to society.
- 2.** To address these grand challenges the United Nations should press for greater collaboration among international science networks, including professional societies and academies, and indigenous and local knowledge holders.

Scientific concerns about the future and the planet

- 1.** Improving ocean science and governance for the development of sustainable ocean knowledge-based economies
- 2.** Reversing global biodiversity loss and creating a new paradigm for the global tropics
- 3.** Developing a global strategy and response system to fight infectious diseases and antibiotic resistance
- 4.** Ensuring national public investments in basic research as a fraction of GDP (0.2–1 percent)
- 5.** Averting human disasters through prediction of extreme environmental events
- 6.** Changing the fossil fuel paradigm through development of affordable emissions free technologies
- 7.** Providing potable water for all
- 8.** Addressing the nexus of stressed planetary resources such as water, food, and energy, their unequal use, and population growth

² The Delphi method is used to distill knowledge and build reliable consensus among experts who may not be in the same geographical location. In this case it involved three rounds of structured, sequential questioning of the members of the UN Scientific Advisory Board, with controlled feedback.

³ http://en.unesco.org/un-sab/sites/un-sab/files/SAB_4_INF_7_Dephi_Study.pdf



UN Photo/Marco Dormino

Solar power: Changing the fossil fuel
paradigm through development of
affordable emissions free technologies



The Scientific Advisory Board
4th meeting in St Petersburg,
Russian Federation, December 2015



National Commission of the Russian Federation for UNESCO

THE SCIENTIFIC ADVISORY BOARD:

Moving forward

The Scientific Advisory Board is a unique and pioneering experiment. Its work has helped create a strong foundation for the United Nations' core mission going forward. Many nations and organizations, indeed a number of other UN agencies, turn to appointed science advisors or advisory committees for counsel on scientific matters. But there is no other body that has the global scale and high-level audience of the UN Scientific Advisory Board, appointed by the UN Secretary-General; the broad scope of its mandate; and the diversity of disciplines, experience, and national backgrounds.

Sustainable development is now the core of the United Nations' mandate. Science will be critical to the implementation of the new global goals, and scientists will be necessary partners. One can expect progress on the 17 SDGs if policy-makers employ and engage science well.

In his remarks to the inaugural meeting of the UN Scientific Advisory Board in January 2014 Secretary-General Ban Ki-moon noted humanity's entrance into a new era of the Anthropocene where human activity has a direct and measurable impact on the planet's life-support systems.

The transition to this new era is not understood fully, but the responsibility to grasp its consequences as rapidly as possible is clear. There can be no reluctance to "tackle the big issues," the Secretary-General said at the time. And to this end, one certainty is that:

"We need more integrated policies... scientific approaches that overcome barriers... a holistic vision of the challenges... and local and global political leadership informed by solid science."

Members of the Scientific Advisory Board believe that the Board's work has answered this call. The Board has responded to inquiries from the Secretary-General, such as the policy brief on the data revolution that emphasizes the need to avoid widening the rich/poor information gap. It has done significant work on its own initiative, such as the report highlighting the value of local and indigenous knowledge. It has supported other work by the United Nations and the global community, such as the policy brief on the risks of climate change. And it has eagerly tackled big issues, as in the Delphi study of grand challenges.

In a survey of Board members conducted for this report, the majority says they believe the Board

The Board urgently needs an independent funding stream to support its work between the formal meetings and facilitate the convening of Board meetings in countries around the world.

has been effective by a number of measures, though more so, initially with the Secretary-General than with UN agencies.

The survey also reflects nearly unanimous agreement that UNESCO has effectively provided the secretariat functions for the UN Scientific Advisory Board even in the face of severe financial challenges. However, the Board urgently needs an independent funding stream to support its work between the formal meetings and facilitate the convening of Board meetings in countries around the world. To date, the five Board meetings have been fully supported by the host governments and by UNESCO rather than by a dedicated budget for its operations.

The UN Secretary General Ban Ki-moon with Chairperson, Irina Bokova, and members of the Scientific Advisory board, in New York, July 2015



The Board reports that it has benefitted from its gender parity; from the diversity of disciplines, experience, and national backgrounds of its membership; and from a growing collegiality.

Looking ahead, one task that the Board, in collaboration with others, could readily undertake is to determine and map the various science advisory mechanisms within the UN, in the interest both of efficiency and effectiveness.

More broadly, the Board promises to become even more important as the world takes up the work of overcoming global challenges. As the Secretary-General's admonition suggests, policies will be able to respond adequately only if they are clear, agreed-upon, and powerful, and such policies will be developed only if science is fully engaged.

The UN Scientific Advisory Board is situated at the nexus of these issues, uniquely positioned to ensure that priorities are set, focus is maintained, the right parties are convened, investments are made, data are mined, challenges are communicated, and optimal decisions are made, because they are based on solid science. The Board, through its focus on science, technology, and innovation, sees itself as a driver and enabler of an inclusive and people-centered sustainable development agenda.

Several suggestions for the governance of the Board in its next chapter are enumerated below.

RECOMMENDATIONS

- 1.** The Board is ready to take on a more visible and active engagement with the scientific community.
- 2.** A focal point for the Board within the office of the Secretary-General should be established. This would foster better communication with the Secretary-General as well as a range of UN agencies.
- 3.** The Board recommends a well-resourced secretariat, exclusively working for the Board.
- 4.** Members believe the Board has gradually developed a strong sense of collegiality that has heightened its effectiveness and recommend staggered terms of service – providing both refreshment and continuity.



- ▲ Members of the Scientific Advisory Board and observers at Board's 5th meeting in Trieste, Italy, May 2016, at The Abdus Salam International Centre for Theoretical Physics
- ◀ Scientific Advisory Board members at work

UN headquarters, New York:
projection of the 17 SDGs to raise
awareness about the 2030 Agenda



CONCLUSION

This report builds on the work of all members of the UN Secretary-General's Scientific Advisory Board, including numerous discussions, presentations, meetings, and policy briefs.

If the Board were seeking to make headlines with this report, we could focus on some of the world's most challenging threats, and describe trend lines that are now headed toward places where no one wants to go. This would be fully justified. Yes, it is possible that climate change can cause catastrophic harm in decades, not centuries; that population growth will accelerate, especially in the world's poorest countries; that international conflicts will become more frequent because of disputes over water rights, food, economic pressures, and unequal access to information.

But we choose instead to take a more optimistic tone. We believe that solutions to many of the most pressing problems are essentially known now, and those problems can be mitigated effectively if approached cooperatively and if world powers contribute the resources required to implement the solutions. Achieving the needed level of cooperation will be far more likely if science is used to describe the problems accurately, to point to the needed policy responses convincingly, and to enable effective

implementation. Likewise, where solutions to global problems are not yet clear, it is science that is pointing ways toward finding them.

Recent experience proves that science can be not only strong but fast, that breakthroughs often occur when least expected, and that scientists and policy-makers, working together, need not be intimidated by even the world's most formidable challenges. The eradication of once-devastating diseases, rapid improvements in agriculture, and the response to climate change are examples that illustrate this vividly; there are and will be others.

It is true, of course, that the application of science can also have harmful effects. Science should be characterized by independence, diligence, prudence, and humility. The scientific community has to reflect on its responsibility to society and the planet and be aware of possible misuse of its work.

It is universally acknowledged that the first step toward solving a problem is to name it. The United Nations' 2030 Agenda for Sustainable Development makes long strides in that direction through its 17 Sustainable Development Goals and 169 targets. All, or nearly all, of these rely on science in one fashion or another.



TRANSFORMING OUR WORLD:



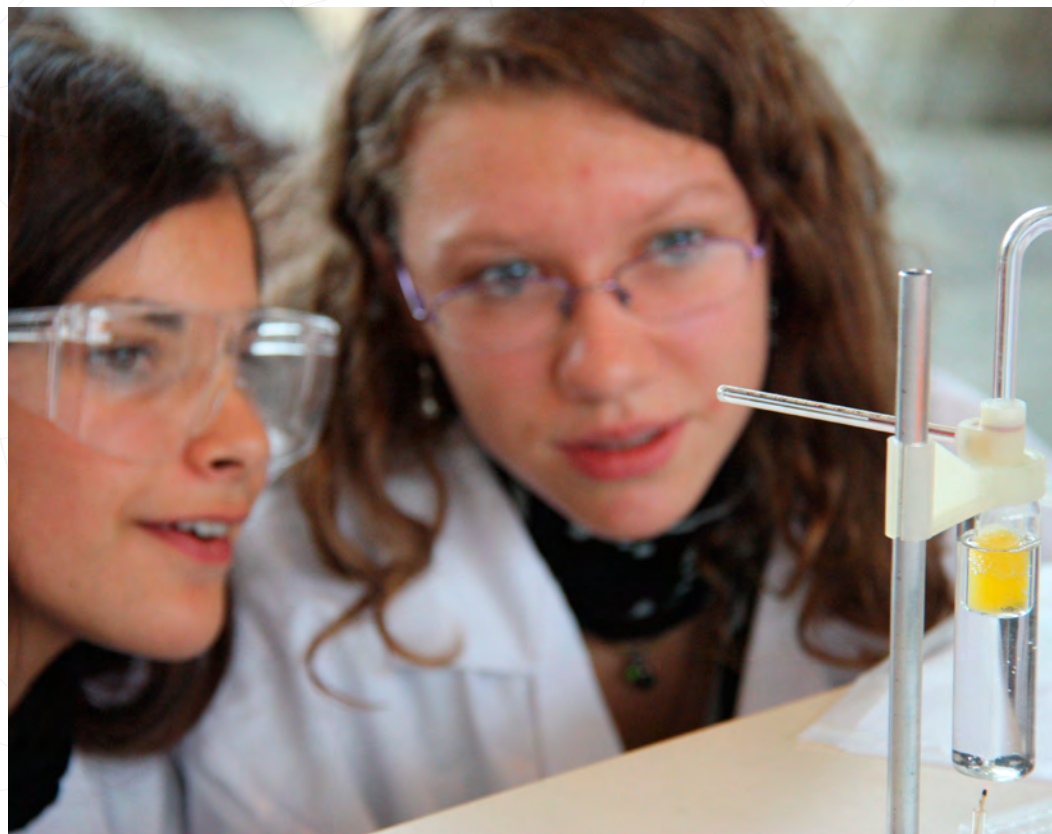
THE 2030 AGENDA FOR
SUSTAINABLE DEVELOPMENT

This underlines one of our central messages: that science is not an add-on but an integral part of the response to all these challenges, that indeed the only way we can have confidence in the world's ability to surmount some pretty daunting threats is if the policies we rely on are built, brick by brick, by science.

And even beyond the specific global challenges, this Scientific Advisory Board believes the United Nations has shown that the effective convening of the world community to confront its most serious challenges has itself eased global tensions. All parties are much more likely to work together if the essential problems are understood, and the necessary policies agreed-upon. Critical to this is the power of science to identify the fundamental problems with certainty, and to discover the optimal policies.

The UN Scientific Advisory Board has provided the foundation for interdisciplinary scientific advice to the UN Secretary-General. In coming years, it can work with UN agencies and the broader scientific community to engage science systematically and sustainably as the United Nations seeks to resolve global problems and facilitate the implementation of the Sustainable Development Goals.

The United Nations has shown admirable leadership in science-informed global policy-making at the highest levels. In the age of the Anthropocene, it will have the opportunity – and in truth the obligation – to provide even more.



UNESCO/ Pilar Chiang-Joo



Celebration of World Science Day at UNESCO Headquarters

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