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# The International Atomic Energy Agency: Linking Nuclear Science and Diplomacy

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NUCLEAR technology is everywhere, contributing quietly and efficiently to improvements in human well-being. Governments and citizens around the world are reaping the benefits of nuclear science and technology, not only in the realm of energy production, but also in fields as diverse as agriculture, health, industry, water management, and environmental monitoring.

The traditional rallying call of the International Atomic Energy Agency (IAEA) has been "Atoms for Peace," based on the famous address of U.S. President Dwight D. Eisenhower to the UN General Assembly in 1953 in which he called for experts to be "mobilized to apply atomic energy to the needs of agriculture, medicine and other peaceful activities." More than sixty years later, the IAEA's Director General Yukiya Amano has emphasized the importance of atoms for peace

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and development, reflecting the understanding of just how beneficial the latest advances and applications of nuclear technology are to human wellbeing.

Many people may not realize how widespread the peaceful uses of nuclear applications have become today. With governments sharing the benefits of applied nuclear research across borders globally, it is appropriate to start associating nuclear technology with the scientific, peaceful, diplomatic, and development benefits it provides. The IAEA is the world's center for cooperation in the nuclear field, with 164 member states sharing information and cooperating to promote safe, secure, and peaceful uses of nuclear technology. Nuclear science and diplomacy sit hand in hand and represent a key element of the IAEA.

Established in 1957, the IAEA is the only organization in the UN system with expertise in nuclear technologies. The agency serves as an important global platform for strengthening nuclear security. It provides a system of fundamental safety principles that reflect international consensus on protecting people and the environment from the harmful effects of ionizing radiation. It provides standards for all types of nuclear facilities that serve peaceful purposes and, through its inspection system, verifies that all member states comply with their commitments under the Nuclear Non-Proliferation Treaty and other agreements to use nuclear technology for peaceful purposes. The organization also maintains a number of specialist laboratories where researchers from around the world share knowledge and expertise on the peaceful and beneficial applications of nuclear technology.

While the IAEA is always mindful of the importance of safety and security, it also has a role in advancing the real power of nuclear technology to bring sustainable social, economic, and environmental benefits to billions of people. And it is here that the IAEA has much to contribute through the interaction between scientific knowledge and diplomacy. One area where these links can be clearly illustrated is in access to clean water.

**Water**

"Water . . . Of the riches that exist in the world, thou art the rarest and also the most delicate—thou so pure within the bowels of the earth!" So exclaimed Antoine de Saint-Exupéry, the French writer and aviator who almost died from dehydration after crashing his plane in the Sahara Desert in 1935. After several desperate days, he came to understand the "infinitely simple joy" that water spreads in the world. It is all too easy to take this precious resource for granted until it is taken away. All life and all civilization are ultimately dependent on water, and debate and negotiations on how to use and share it sustainably are essential to peaceful human development.

This is particularly true with the rising scarcity of freshwater. With agriculture consuming about 70 percent of global freshwater and the increasing effects of climate change, the need to improve the management of this resource has never been so urgent. Identifying and understanding shared, transboundary water

resources and improving agricultural water management are examples of the multifaceted nature of the IAEA's work. Upstream users may withdraw or pollute to the detriment of downstream users, or many nations may share a single aquifer from which withdrawals may be replenished slowly or not at all. It can be difficult to truly grasp that freshwater is limited, that it can deplete rapidly, and that the serious degradation of ancient aquifers is a very real possibility.

In May 2015 the IAEA hosted the 14th quadrennial International Symposium on Isotope Hydrology at its headquarters in Vienna, drawing together more than four hundred professionals to exchange the latest technology and research on isotopic techniques and their application. Director General Amano commented on the need for scientifically rigorous evidence to support policy planning and the allocation of water resources. "Nuclear science—and the techniques of isotope hydrology, in particular—have a key role to play in developing the scientific evidence that Member States [of the IAEA] need in order to manage their water resources and to respond to the effects of climate change," he said. Many countries are now using nuclear science to track aquifers and identify the water's origins, movements, and destinations. This increased understanding of the cross-border identity of water can promote cooperation among countries, improve agricultural water management, and help ensure an equitable distribution of the available resources between neighbors.

The IAEA, through its water resources program, supports countries in undertaking isotopic analysis of water to accurately assess the age, origin, and evolution of groundwater resources, as well as its quality and risk of contamination. Determining the age of an aquifer and how quickly it is being replenished are crucial to estimate how much water can be sustainably withdrawn from potentially fragile systems. In scientific terms, water can be dated using radioactive isotopes, especially carbon-14 and krypton-81. These unstable isotopes release energy as they decay and are transformed into stable isotopes. Based on the time necessary for the radioisotopes to decay and the current isotope content, scientists can measure the water's age. These precise measurements create a valuable data bank that helps to establish protective measures for the appropriate and knowledgeable use of the world's precious underground water heritage.

There are many examples of IAEA-supported projects that, by focusing on transboundary water resources, show how scientific collaboration brings countries together and solves potential problems early.

In the arid regions of North Africa, where Antoine de Saint-Exupéry experienced his epiphany on water, lies the Nubian Sandstone Aquifer, one of the world's largest "fossil" water aquifers that supplies Chad, Egypt, Libya, and Sudan—an area with a total population of more than 130 million. The underground reservoir is huge, but demands on it are steadily increasing and the scientific evidence indicates that the aquifer has been slowly draining since the last glacial period.

The work done on the joint Nubian Aquifer Project by the four states with the support of the IAEA, the Global Environment Facility, and the United Nations Development Programme illustrates how science informs diplomacy and how diplomacy, in turn, can rely on science. The partners in the Nubian Aquifer Project have developed innovative three-dimensional models of the aquifer that enable mapping of water movement through it. The analysis of krypton-81 isotopes have made it possible to confirm the age of groundwater pumped from the oases in the Western Desert and helped to make the models more accurate. The analysis shows that the water is old, ranging in age from hundreds of thousands of years to more than a million years. These results indicate that the aquifer is not refilling quickly and that without careful management and cooperation, it will continue to deplete and become increasingly difficult to access.

Scientists and staff of the water ministries in the four concerned countries have participated in every stage of the project development. In the wake of the research, and after decades of water-related tensions, all the countries relying on the Nubian aquifer have agreed on the necessity for mutual collaboration for its protection. All sides use a common language in terms of sharing and interpreting the wealth of data created, and the member states are designing cooperative monitoring programs to jointly manage the resource accordingly. As agreements are reached, it is clear that science constitutes a tool for political consensus and provides a bridge between different interests and sensitivities—truly, science and diplomacy in action.

An ocean away, the Guarani Aquifer is the largest freshwater resource in Latin America, spread over 1.2 million square kilometers with tens of millions of people in Argentina, Brazil, Paraguay, and Uruguay relying on it as a source of drinking water and for irrigation and industrial use. The cooperation engendered through the research conducted in this region is another example of the interaction of science and diplomacy at its best. With support from the IAEA and other international organizations, the four concerned states analyzed and assessed the aquifer using isotopes. The database, which was established from 2003 to 2009, gave the four countries information to help them consider how best to preserve and use the resource sustainably. One of the follow-up projects involving Argentina, Brazil, and the IAEA has revealed that the groundwater in the central areas of the aquifer is up to 800,000 years old even in this humid, tropical land.

The IAEA and its member states have been collecting and creating a large body of isotope data on the world's rivers, lakes, and aquifers that can be used for resource assessment and management on a local, regional, and continental scale. Isotope hydrology atlases based on years of data collection are now readily available to scientists worldwide. Since 2007, the IAEA has compiled and released water resources atlases for Africa, Asia, the Pacific, and the Americas based on more than forty-five thousand measurements collected from sixty-five countries. Mapping more of the world's groundwater according to age and renewal rates,

through the planned completion of a world atlas, will help build peaceful and lasting relationships over this shared resource, fundamental to sustainable development.

**Health, Food, Agriculture, Industry, and Environment**

The work being carried out in water is just one example of the many peaceful uses and applications of nuclear technology being supported by the IAEA. Health has risen in global political importance as today the world faces substantial health challenges—from the spread of infectious diseases to gaps in basic maternal and infant care to the globalization of cancer—that pose significant threats to international health security.

There is a strong focus on early life nutrition for the prevention of non-communicable diseases. In this critical area of early healthcare, stable isotope techniques are being used to assess changes in body composition and the bioavailability of nutrients, thereby allowing the evaluation of programs designed to prevent and treat malnutrition.

Diagnosis of non-communicable diseases, such as cancer and cardiovascular diseases, involves several nuclear technologies such as positron emission tomography and computed tomography (i.e., PET and CT scans). Once a cancer is diagnosed, treatment can often include radiotherapy through gamma rays, electrons, and charged particles (protons and carbon ions). These treatments involve significant investments in infrastructure and equipment as well as training for qualified professionals to run these departments and supervise quality assurance protocols.

The IAEA and the UN's Food and Agriculture Organization (FAO), through the Joint FAO/IAEA Division, are working to support the appropriate use of nuclear technologies in food and agricultural production, especially in improving agricultural water management. Improving agricultural practices and maximizing the efficiency of agricultural water use can save vast amounts of freshwater, which will have important food security, water and food quality, health, and economic benefits. Other areas of support using nuclear technologies include the control of insect pests, such as the Mediterranean fruit fly and Tsetse fly, through the sterile insect technique, a major area of research and applied technology in many countries.

The industrial applications of nuclear technology, too, are far-reaching and will be showcased at the Scientific Forum held annually at IAEA headquarters in Vienna. This year's theme is "Atoms in Industry," which will illustrate how radiation technologies are used in industry, bringing socioeconomic, health, safety, and environmental benefits with them. A whole range of new, "greener" industrial applications is contributing to sustainable development and production of high-quality products, while the wealth of data accumulated through nuclear

spectrometry and accelerator science is leading to further developments in the peaceful and beneficial applications of nuclear technology.

Activities to understand the natural environment and monitor pollution are carried out through IAEA laboratories in Austria and Monaco. Research, especially on the impacts of climate change and ocean acidification, is providing the accurate information that helps countries monitor and protect sensitive terrestrial and marine ecosystems.

## Science and Cooperation at IAEA's Core

Science provides the basis for agreements between governments based on mutual confidence and openness in gathering data and reaching conclusions.

The massive database of knowledge accumulated and the research conducted through thousands of collaborative projects undertaken with the support of the IAEA have contributed immeasurably to the capacity of member states to share and understand their precious resources, strengths, and opportunities. This knowledge informs policy makers and enhances relations between countries through the facilitation of international science cooperation: North-to-South cooperation, for example, is enhanced through projects focused on the needs and priorities of less developed countries, and the wealth of research projects conducted by PhD researchers and others from developing nations reflects this.

Solid mechanisms support this research, and these activities will continue to be expanded and adapted to address the needs of today's world. The IAEA contributes to resolving challenges that countries have in common, drawing on its unique expertise to continuously open new horizons for peaceful, global, and sustainable development. International collaboration will continue to flourish, and the shared science and technology that is developed will become ever more beneficial to humankind as countries seek a safe and sustainable path into the future. **SD**

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