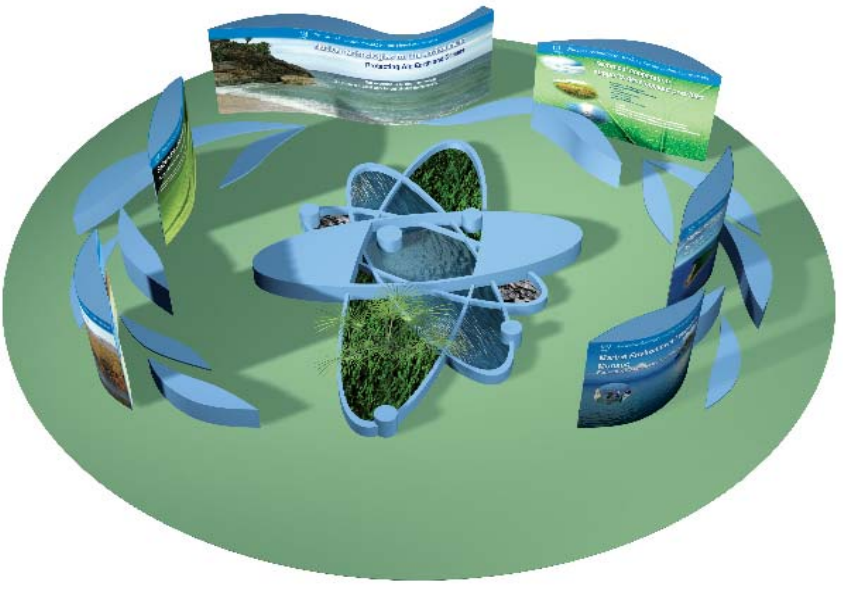
IAEA

Atoms for Peace: The First Half Century
1957–2007

Nuclear Technologies for the Environment

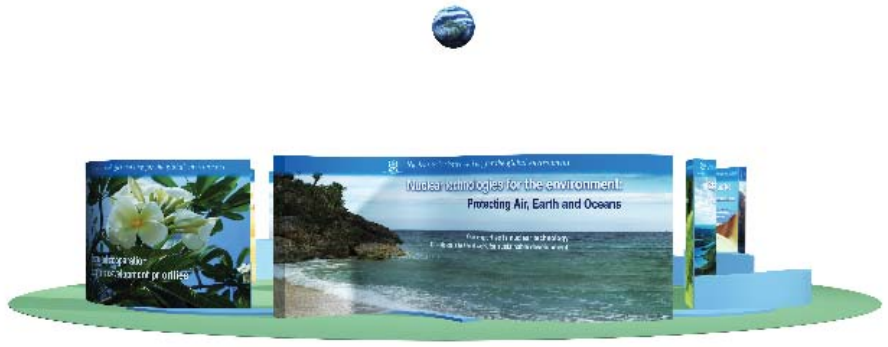
Protecting Air, Earth and Oceans



Air, earth and oceans *comprise the primary elements of the* ***earth system*** *— a complex and interconnected system regulated by physical, chemical and biological processes.*

Every person relies on these elements for the supply of basic needs.

However, everyone has an impact on the overall availability of these elements and their underlying quality.



Air

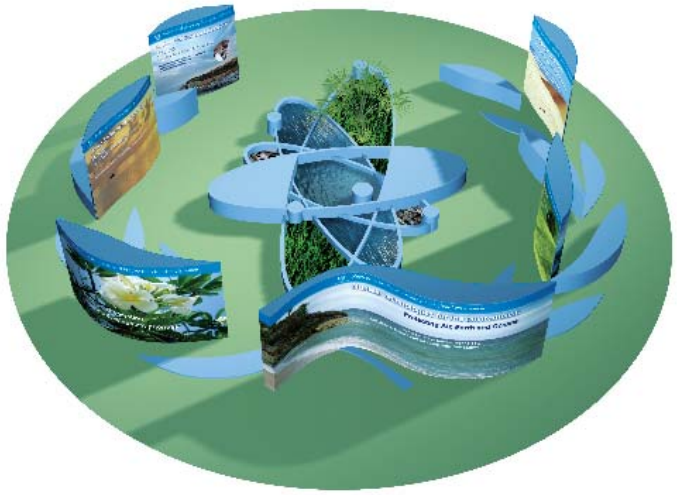
Since the Industrial Revolution, human activity has significantly changed the air that we breathe. Concentrations of carbon dioxide (CO_2) have increased by about 31%, methane (CH_4) has more than doubled, and nitrogen oxide (NO_x) has risen by 17%. Clear evidence links these increases to the burning of fossil fuels, which also leads to air pollution that causes health problems.

Earth

Scientists have mapped 867 land based ecosystems around the world, each distinct in its mix of climate and plant and animal communities. Many are experiencing rapid change; some are already severely damaged. To prevent or reverse degradation, we must develop integrated approaches to land management. The first step is to understand the unique features of the ecosystems that we rely upon for food and natural resources, and in which we live and work.

Oceans

Two thirds of the world's population lives within 60 km of a coastline. We draw upon oceans for food and marine resources. In return, we fill them with the by-products of industry, agriculture and day to day living. Oceans are the primary driver of global environmental change: preserving their integrity is vital to protecting our future.



Around the world, *the IAEA's Technical Cooperation Programme is helping Member States achieve their development priorities while also taking measures to protect atmospheric, terrestrial and marine environments. Nuclear technologies play a vital role in this effort.*

In many ways, nuclear techniques are a means of using the elements of nature to conduct investigations. Stable and radioactive isotopes[1] are found in every environment. Tracing their movement helps obtain new knowledge about biogeochemical processes. Tagging them to another material offers the opportunity to watch them in action — that is, to determine what scientists refer to as their 'behaviour' and 'fate' — and to see how they influence the systems in which they move.

Nuclear technologies can be used to assess global resources. They also enable mapping and prediction of future trends. Information acquired through nuclear techniques can support policy development and prompt action.

Protecting environments is largely a matter of reducing abuse and making better choices for their use.

[1]Isotopes are different forms of a given element, as determined by the number of neutrons in the nucleus of the atom. A radioactive isotope has an unstable nucleus that emits radiation as it decays.

As part of the IAEA's broader programme for the environment, nuclear methods are increasingly applied in the following areas:

- Monitoring, assessment and protection of air quality.
- Reduction of threats to water resources.
- Improvement of land productivity.
- Prevention of disease.
- Sustainable generation of electricity.
- Prediction and understanding of natural phenomena.
- Management of marine environments.
- Rehabilitation of contaminated land and water.
- Treatment of waste water from nuclear power plants.

Air

Local impacts in Latin America's megacities

Buenos Aires, Mexico City, Santiago and São Paulo are cities characterized by high population densities, vast numbers of motor vehicles and heavy industry. This is a combination in which everyone stands to lose. Cars and factories emit high levels of particulate matter, individuals suffer respiratory problems and diminished quality of life, and the economy is left to contend with absenteeism and lower productivity.

Local authorities are collecting air samples to identify — using special X ray techniques (particle induced X ray emissions or PIXE) — the components of particulate matter (e.g. sulphur, copper, zinc, lead) and correlate these concentrations with the incidence of respiratory disease. The goal is to create emission regulations that will improve air quality and human health.

Transboundary trends across Asia and the Pacific

A similar project in Asia[2] considered not only local impacts but also how air pollution travels across international boundaries. Increasing each participating country's capacity to monitor and assess air pollution made it possible to gather data to identify critical pollutants and their sources — both near and far. This extensive data collection will support future work on transboundary movement and developing models to forecast air pollution trends.

[2]This was a joint project with the United Nations Development Programme involving Australia, Bangladesh, China, Indonesia, the Republic of Korea, Malaysia, Myanmar, New Zealand, Pakistan, the Philippines, Singapore, Sri Lanka, Thailand and Vietnam.

Africa collects evidence to prove a point

For African countries initiating air quality programmes, one key challenge is convincing policy makers, industry and the general public to take air pollution seriously — that is, to modify regulations, production methods and behaviour. The IAEA helped 16[3] countries acquire nuclear based monitoring equipment that can be used to gather data and demonstrate that control measures do make a difference.

Global effort to reduce industrial emissions at the source

A large part of air pollution, particularly sulphur dioxide (SO_2) and nitrogen oxide (NO_x), is caused by industrial dependence on fossil fuels. The problem is heightened in many developing countries, where economic factors make it necessary to use low grade 'dirty' fuels such as coal. Demonstration projects in Brazil, China and eastern Europe have shown that a process known as electron beam dry scrubbing (EBS) removes up to 95% of these pollutants from flue gases in coal fired boilers. It also creates a by-product that can be used as fertilizer. Saudi Arabia is now assessing EBS feasibility in oil fired boilers.

In 2005, over 1200 IAEA technical cooperation projects (valued at $73.6 million) involved nearly 2400 institutions. Support to human resources development benefited over 6000 individuals through fellowships, training and assignment of 2784 experts.

[3]Algeria, Burkina Faso, Cameroon, Egypt, Ethiopia, Ghana, Kenya, Madagascar, Mauritius, Morocco, Niger, Sudan, Tunisia, United Republic of Tanzania, Zambia and Zimbabwe.

Earth

Additional land for farmers in arid regions

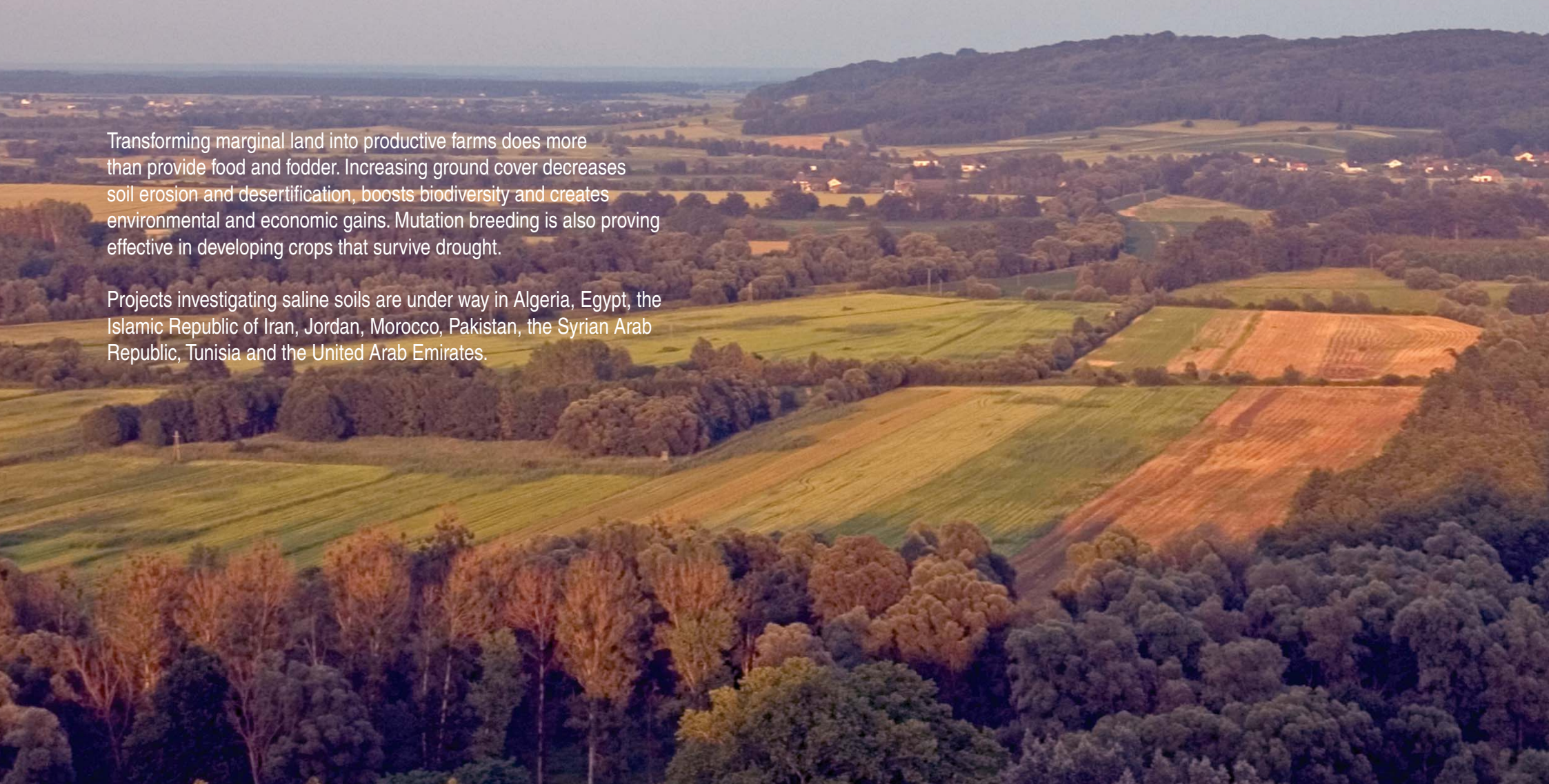
Salty soil is a worldwide phenomenon that in some regions is natural but in others (covering approximately 77 million hectares) is the end result of human factors. Efforts to leach salt from surface soil through freshwater irrigation have been largely ineffective.

Nuclear technologies support a novel approach that combines nature and nurture. Mutation breeding, based on selection of native plants that meet local needs, is being used to enhance more than 100 plant species that show some salt tolerance. Neutron moisture probes support optimal irrigation practices; isotope hydrology determines the sustainable use of water resources. Other techniques monitor factors such as plant–soil–water interactions and species competition for soil moisture, as well as the nutritional value of harvested crops.

Crops and livestock in combination

Sustainable farming aims to minimize impacts on farmland, but it is equally important to consider the plants and animals that ultimately provide livelihoods for farmers.

In east Africa, efforts are under way to break a cycle in which poor soil fertility status leads to nutrient deficient crops, malnourished herds with low reproduction rates and impoverished farming communities. Using legumes as biofertilizers, farmers are now essentially improving soil nitrogen status and supplementing animal fodder with nitrogen- rich crop residues and industrial by-products. Nitrogen-15 isotopic techniques are utilized to quantify and enhance legume's capabilities to fix atmospheric nitrogen and thereby providing better nitrogen inputs to the soil. Where appropriate, artificial insemination supported by nuclear techniques is also being used to boost livestock reproduction. In the short term, the efforts increase food production; in the long term, they sustain food security and preserve the natural resource base.



Transforming marginal land into productive farms does more than provide food and fodder. Increasing ground cover decreases soil erosion and desertification, boosts biodiversity and creates environmental and economic gains. Mutation breeding is also proving effective in developing crops that survive drought.

Projects investigating saline soils are under way in Algeria, Egypt, the Islamic Republic of Iran, Jordan, Morocco, Pakistan, the Syrian Arab Republic, Tunisia and the United Arab Emirates.

The IAEA's technical cooperation portfolio demonstrates that five of the eight UN Millennium Development Goals in the areas of environmental sustainability, combating disease, hunger and poverty, as well as maternal/child health and nutrition, are being addressed.

Fewer pests, less pesticide and new market possibilities

Conservative estimates suggest that pests reduce the world's food supply by 25%. The presence of pests is associated with overuse of pesticides, as well as serious and sometimes fatal diseases in livestock and humans. The sterile insect technique (SIT) is an irradiation process that leaves laboratory bred male pests infertile. When released in target environments, these males mate, but the females produce no offspring, thereby reducing the pest population.

The effective application of SIT involves many challenges, such as sustaining field operations, but several countries have reported noteworthy successes. In Zanzibar, eradication of tsetse flies — and thus of the incidence of sleeping sickness and trypanosomiasis — improved cattle breeding and eliminated the use of pesticides. In the Arava Valley of Israel, where the use of conventional pesticide cover spray is banned, finding an alternate way to address fruit fly infestation created opportunities for export to US markets.

Projects in 22 countries in Africa, 17 in Asia and the Pacific, two in Europe and 18 in Latin America have dealt with sterile insect techniques.

From China to Chile: Reducing soil erosion

Remote sensing surveys show that 38% of China's total territory is degraded by soil erosion. In Chile, 60% of agricultural land has a reduced capacity to produce. While not always so severe, soil erosion is a global problem that often stems from irrational land use and poor farming practices that reduce plant cover.

Integrated land management strategies are urgently needed on every continent. To be effective, they must consider many factors, including landscape, soils, vegetation cover and sediment production. Tracking the migration of radionuclides (e.g. caesium-137) is one means of measuring soil redistribution and assessing the suitability of various conservation strategies.

Oceans

Modelling the future of the south Mediterranean Sea

Shallow depth and limited water exchange make the Mediterranean Sea particularly vulnerable to human influences. Rather than circulating, contaminants tend to concentrate. This may influence natural processes in the water column and ultimately affect marine life and productivity, which are already poor compared with other sea systems.

Until recently, relatively few data were available on this body of water. Scientists took part in programmes to capture data on radioactive and non-radioactive contaminants in water, sediments and biota, and to map trends in their movement over space and time. Part of the data will be synthesized to determine the sea's current health status and develop a comprehensive marine information system for the south Mediterranean Sea. The system will include computer models to help manage the sea's future. Based on experience gained, a five year (2007—2011) regional project for African countries with sea coasts will be established for "Enhancing African Regional Capability for Contamination Assessment in the Marine Environment."[4]

Bringing the Black Sea back to life

In the early 1990s, the Black Sea was declared 'nearly dead' in terms of water quality, biodiversity, habitats and recreational value. Over five years (1997–2002) the IAEA helped scientists from six Member States[5] join forces to identify toxins, seek out their sources and develop remediation strategies. Radionuclides were both a subject of concern and an invaluable investigative tool, acting as tracers to reveal the behaviour and fate of other contaminants.

[4]This project involves scientists from Algeria, Egypt, the Libyan Arab Jamahiriya, Morocco and Tunisia, and will be integrated with other ongoing and planned activities organized by the United Nations Environment Programme (UNEP), the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization, the European Union and the Food and Agriculture Organization of the United Nations (FAO).

[5]Bulgaria, Georgia, Romania, the Russian Federation, Turkey and Ukraine.

Taking care of the Caribbean's most vital resource

For small islands and coastal countries, exploitation of marine resources can account for as much as 60% of gross national product (GNP). Across the Caribbean, overpopulation and conflicts over coastal land use are raising concerns that what goes into the marine environment (e.g. domestic and industrial waste) affects the quality of marine products and services.

A four-year project (2007–2010) will use natural and human-made radionuclides to examine contaminants in ocean sediments, subtidal and wetland areas and the atmosphere. A particular focus will be placed on using radiotracers to follow the trail of contaminants that enter the food chain, potentially threatening the health of local inhabitants and tourists who support 34% of GNP and generate more than 2.4 million jobs.

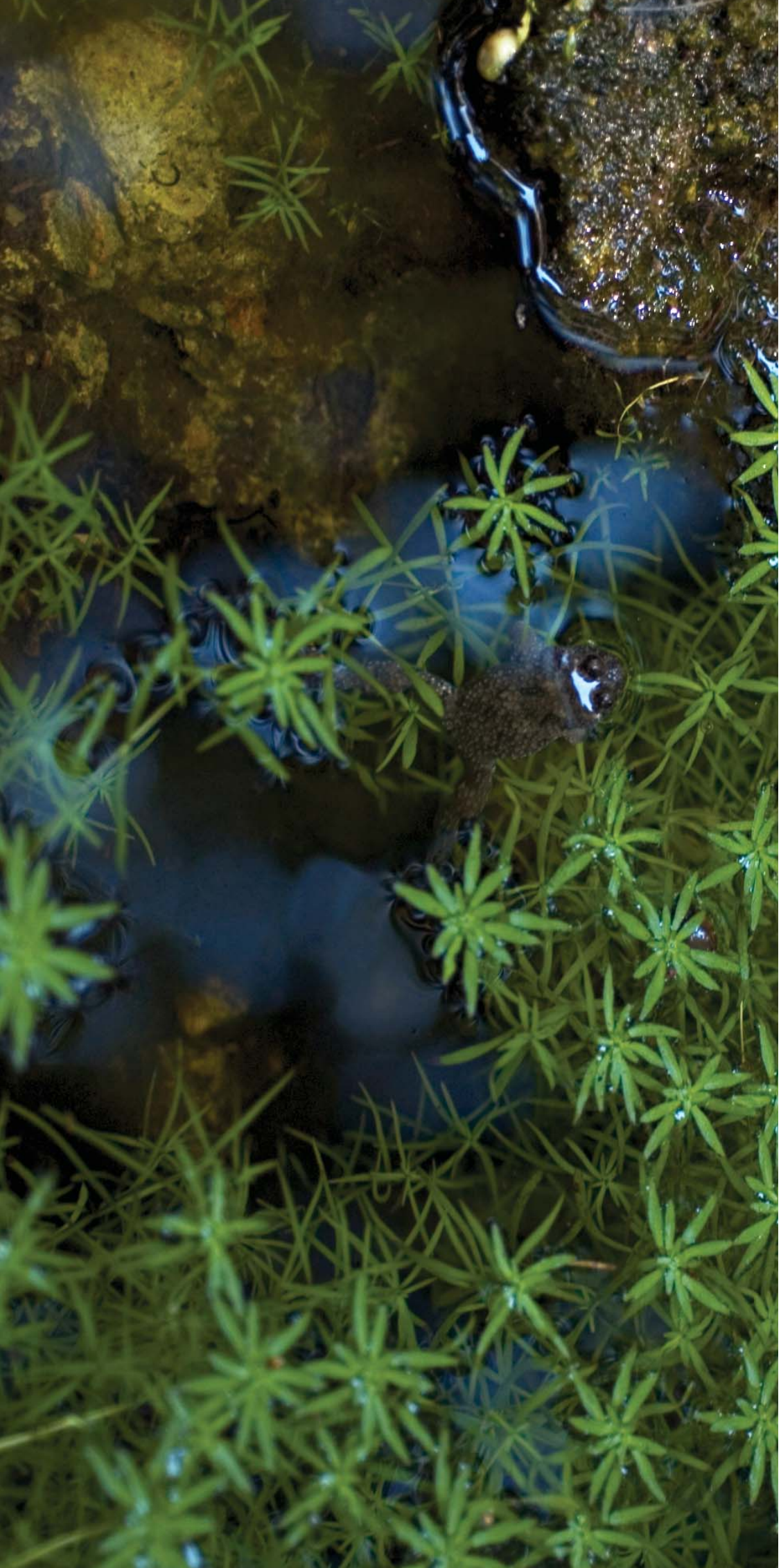
Member States involved in this project include Colombia, Costa Rica, Cuba, the Dominican Republic, Guatemala, Haiti, Honduras, Nicaragua and Venezuela. It will be carried out in collaboration with UNEP and the Association of Caribbean States in support of the Latin American and Caribbean Initiative for Sustainable Development, approved at the World Summit on Sustainable Development (2002).

Keeping marine toxins at bay

In the past 40 years, harmful algal blooms (HABs) — commonly known as 'red tide' — have become more frequent and more widespread. Their danger lies in toxins that are taken up by shellfish and then ingested by humans. The effects range from mild discomfort to paralysis and death.

When HABs occur, regulatory authorities must act fast to close commercial fisheries, warn subsistence harvesters and halt trade in shellfish products. Receptor binding assay (RBA) is a nuclear technique with high sensitivity and the capacity to test large samples in a very short time. Compared with other methods to detect HAB toxins, RBA provides more accurate information about the actual risk and enables authorities to take appropriate action faster.

RBA projects have been undertaken in various countries in Africa, Asia and the Pacific, Europe and Latin America.



Putting nuclear technologies to work for the environment all around the globe

The IAEA is directly involved in a wide range of projects that reflect the need to better understand how human activity influences the air, earth and water environments, and the natural cycles that keep them in balance. Many of these initiatives are regional or interregional, reflecting the shared nature of these valuable resources.

The projects described in this brochure are supported by the IAEA's Technical Cooperation Programme, which strengthens capacity for the application of nuclear technologies in developing countries. The programme provides three key mechanisms to this end:

- **Training** provides scientists, technicians and others with the knowledge and skills needed to apply nuclear techniques in the laboratory and in the field. In addition to enhancing Member State ability to carry out sampling missions, monitoring and assessment, training strengthens capacity in relation to information systems, particularly data collection and storage, analysis and interpretation.

- **Expertise,** through leading experts working with country counterparts (e.g. local scientists and policy makers), addresses specific problems, typically by providing advice, lecturing at training courses or contributing to meetings and workshops.

- **Equipment** underpins the goal of self-sustainability through technical cooperation. With the right tools, skilled individuals with first-hand knowledge of local issues can apply their expertise more effectively and over the long term.

Technical cooperation supports development priorities

The IAEA's Technical Cooperation Programme spans a range of sectors, several of which directly support UN Millennium Development Goals in the areas of:

- Human health.
- Food and agriculture.
- Water resources and environmental protection.
- Sustainable energy options.

IAEA laboratories contribute to a safe, clean and sustainable environment

The IAEA maintains unique multidisciplinary centres for analysis, research and training. The laboratories support IAEA contributions to the UN Millennium Development Goals, including "ensuring environmental sustainability".

The laboratories at Seibersdorf share the same fundamental mission. Together they develop and apply nuclear technologies to assist Member States in areas such as food and agriculture, water resources, human health, physical and chemical sciences, industry, and the environment. They also play an important role in radiation protection and safeguards verification, matters that are critical to strengthening capacity for the application of nuclear technologies in developing countries.

Laboratories at Seibersdorf and Vienna

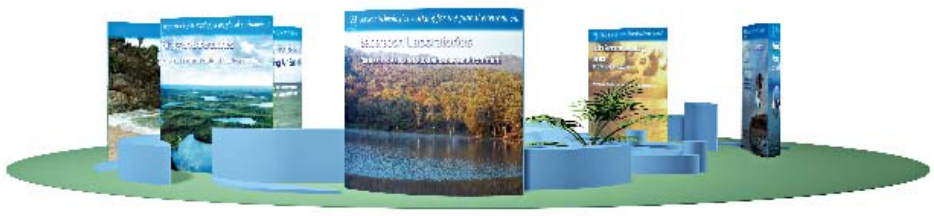
The Seibersdorf Laboratories came into operation in 1961. In January 1962, they distributed the first set of radioactive samples to other laboratories, to hospitals and to clinics in Member States. The three laboratories are:

- FAO/IAEA Joint Agriculture and Biotechnology Laboratory.
- Physics, Chemistry and Instrumentation Laboratory.
- Safeguards Analytical Laboratory.

Marine Environment Laboratory, Monaco

Upon its opening in 1961, the Marine Environment Laboratory (MEL) launched a new era in marine investigation. MEL's mission comprises four interrelated strategic elements:

- **Research** for the protection of the marine environment from radioactivity and pollution.
- **Applications** of nuclear and isotopic techniques for tracking ocean processes, marine ecosystems and pollution impacts.
- **Expertise training and reference materials** to assist Member State commitments to the monitoring and sustainable development of their marine environments.
- **Strategic partnerships** with United Nations and international agencies to implement the World Summit on Sustainable Development programmes for the ocean.



The environment and the IAEA

The IAEA has a dual mandate in relation to the environment.

First, it must ensure that benefits derived from the use of nuclear applications do not result in unacceptable hazards to humans and the environment.

Second, it should promote the development and use of nuclear technologies that increase knowledge of environmental processes and enhance capacity to manage natural resources and promote their sustainable use.

The IAEA actively pursues this mandate in three key areas:

- Protecting humans and ecosystems from ionizing radiation.
- Optimizing the environmental impact of nuclear technology.
- Facilitating the sustainable use and management of natural resources.

Environmental protection and environmental friendliness are addressed by the various programmes of the IAEA in nuclear energy, nuclear safety, nuclear applications and safeguards. Support is delivered to Member States through the IAEA's cross-cutting Technical Cooperation Programme.

Through these efforts, the IAEA directly helps Member States achieve the aim of environmental sustainability as set out in the UN Millennium Development Goals.

Measuring success

The success of the IAEA's environment programme can be measured on many levels. Because of it, the world has a broader, deeper knowledge of processes that drive the earth system and a firmer foundation for taking positive action to support long-term sustainability.

In addition, the legacy of technical cooperation lives on, as research institutes around the world apply nuclear technologies to identify solutions to air pollution, increase land productivity and better manage marine coastal zones.

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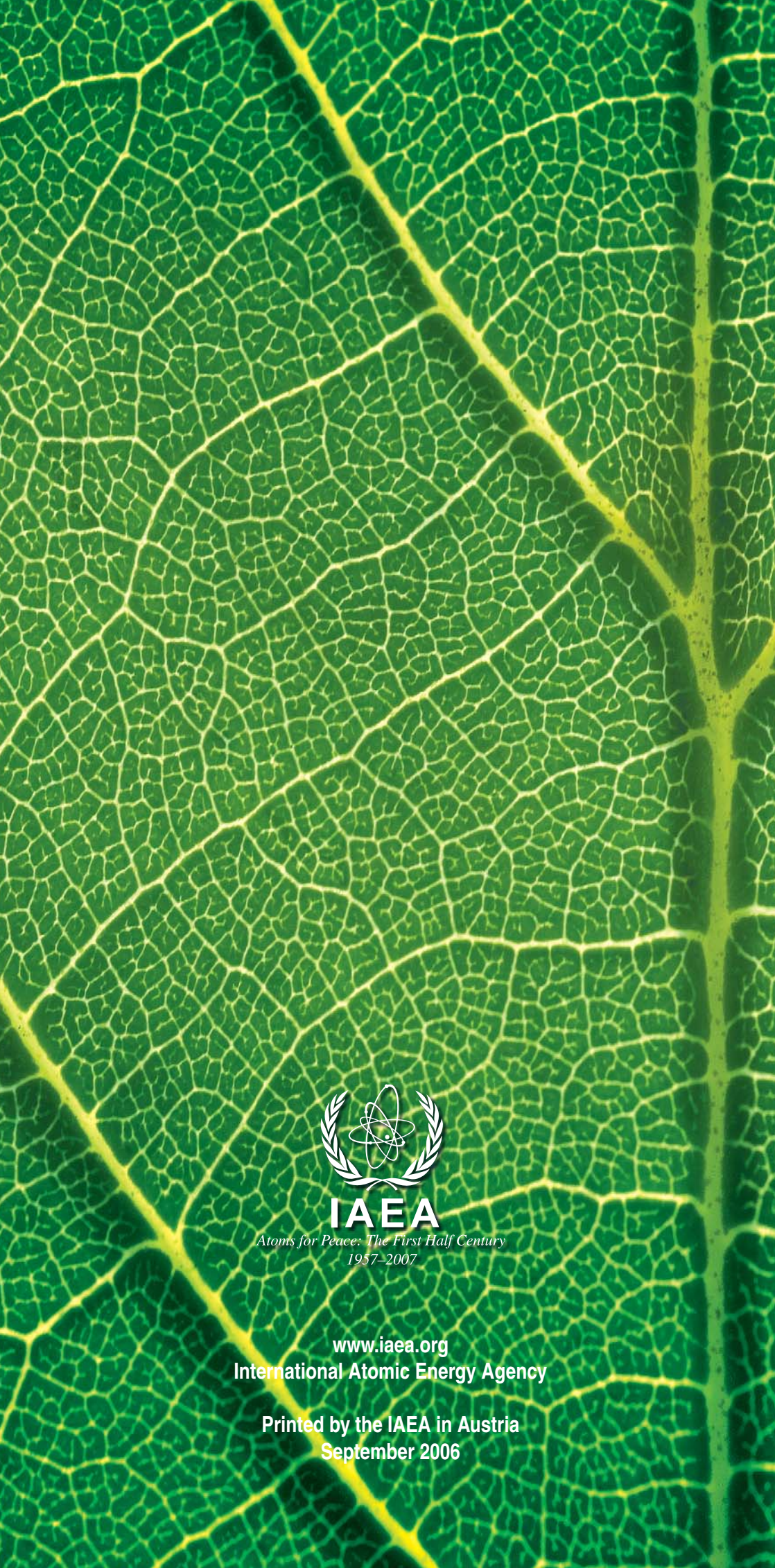
Our expertise is nuclear technologies.
Our vision is to see them work for
sustainable development.



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