*In a world facing severe environmental challenges, nuclear technology can help make the most of natural resources while preserving the environment. An interdepartmental group has been set up to coordinate the multi-faceted efforts of the IAEA in this area.*

# Focus Environment

*by Ana María Cetto and Werner Burkart*



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The sustainability of the Earth's environment has become one of the greatest challenges of our age. An expanding human footprint caused by a growing population, and changes in consumption patterns place undue strain on the planet's ecosystems, as well as its natural resources.

A growing cause for alarm, statistics divulged by the United Nations Department of Economic and Social Affairs (UN-DESA) project a global population of over nine billion by 2050, with commensurate increases in the demand for food, water, energy and other natural resources.

The figures on population growth tie in with the Millennium Ecosystem Assessment, a UN study involving over 1,350 experts worldwide, detailing the severity of the challenges facing humanity: rising demand for energy, climate change, shortage of water supply, desertification, threats to land resources and stress on the marine environment and its natural resources. Other problem areas include rising volumes of polluting waste and worsening air pollution.

Within this dire scenario, human ingenuity and progress, however, offer reasons for optimism. For each of the threats listed by the Millennium Assessment, state-of-the-art nuclear technology can contribute solutions, and, in some cases, offer immediate answers.

As the world evaluates energy sources that would ease our reliance on fossil fuels, an increasing number of countries all over the world are now looking at the nuclear power option. In addition, other technology that is nuclear is essential in assessing, mitigating and predicting environmental impact.

On a practical level, nuclear techniques can help to track water sources and movement for better management of the resource. In the area of land management, nuclear technology can help to quantify the amount of nitrogen fixation, a process hereby atmospheric nitrogen is converted to fertiliser nitrogen in the root nodules of certain plant species — clover, alfafa, beans, peas and peanuts — thus minimizing the need for costly chemical fertilisers.

Nuclear technology can help measure rates of uptake, storage and cycling of water and nutrients in a cropping or livestock grazing system, putting in place management practices that enhance the conservation and management of land and its constituents for food security and environmental sustainability.

# Advancing the Agenda

Agenda 21 is a comprehensive plan of action taken globally, nationally and locally by organizations of the United Nations System, governments, and major groups covering all spheres of social, economic, and human development affecting our environment. The document, adopted at the first Earth Summit in 1992, contains 40 chapters and related topics are thematically grouped in 'clusters.'

Today many nuclear technologies are contributing to sustainable development in countless, and often unheralded, ways. A method known as the 'sterile insect technique', for instance, is a key component of integrated pest management programmes. Nuclear analytical techniques are instrumental to scientific assessments of pollution in the marine environment, while forms of chemical elements called isotopes play vital roles in hydrological studies of freshwater resources deep inside the Earth's crust. Further examples include fighting acid rain in Poland, and promoting child nutrition to communities in Peru and Senegal.

These are just some of the ways in which nuclear science and technology can be applied at the ground level of sustainable development to solve practical problems.

The safe and peaceful use of nuclear technologies underscores the key role that the IAEA plays in advancing the achievement of Agenda 21's ambitious goals.

The IAEA has an extensive number of programmes that relate directly or indirectly to the environment. Taking stock of the broad experience accumulated in this area, the IAEA created a dedicated Focus Group on the Environment (FGE) that looked into these issues with the goal of consolidating the Agency's environment portfolio as an interdepartmental activity in the context of its medium term strategy to 2011.

## The IAEA and the Environment

The scope of the IAEA's involvement in the environmental sphere lies in the sustainable use and management of natural resources, and the protection and understanding of the environment through nuclear technology. The FGE articulated it into three main goals, intended to guide the planning and formulation of the Agency's regular and technical cooperation programmes. The three goals are:

❶ Protecting humans and ecosystems from ionizing radiation;

❷ Optimizing the environmental impact of nuclear technology; and

# an experiment from another age

by Ana María Cetto

2006 marked the 150th anniversary of the world-famous Park Grass Experiment (PGE) in the UK. This experiment is a valuable resource used for a wide variety of scientific observations, leading to a continuous flow of research papers. It constitutes the longest standing ecological experiment of its kind, exemplifing the value of long-term studies to investigate the effects of external factors on population dynamics.

PGE started in 1856, on a hay field that had been in pasture for at least a century. It was the typical meadow that one could find in Southern England at that time — but that has almost disappeared. The experiment, initiated by John Lawes and Henry Gilbert, intended to examine the effects of inorganic fertilisers and organic manures on the yield of grass for making hay. A field of uniform vegetation composition and soil type was originally divided into 20 plots roughly 20 metres wide and 60 metres long, some of which were further subdivided at the beginning of the 20th century. A variety of fertilizer treatments were established and continue to be applied on a regular schedule to the present day. There are also three control plots that are not fertilized at all. The plots are cut each year for hay, usually in June, and a second cut is taken in the autumn.

Within a couple of years, Lawes and Gilbert confirmed their hypothesis by observing increases in the yield as a result of the application of certain fertilizers. However, they also recorded a dramatic reduction in plant species growing on the fertilized plots.

The comparison among the plots today is much more striking. As a result of the treatments they have been subject to over 150 years, the Park Grass communities now represent a wide variety of grassland types. These differ in species richness, net primary production, and soil status. Some are scattered with colourful flowers, others are plush and green, while a few have a felt-like carpet of vegetation. Of particular interest is the dramatic difference in diversity: there are as many as 50-60 species on the unfertilised plots but only two or three species on some of the fertilised plots! Broadly stated, the more nutrients you add, the fewer species you get.

Most people who come across this result for the first time react with surprise: we tend to focus on



❸ Facilitating the sustainable use and management of natural resources.

An Interdepartmental group has now been established to strengthen the IAEA's coordinated efforts towards the achievement of these goals.

## Goal I – Protecting humans and ecosystems from ionizing Radiation

The use of nuclear energy has distinct environmental advantages, e.g., the production of energy with reduced CO2 emission. A central challenge is to ensure that the use of nuclear energy and other nuclear applications does not result in unacceptable hazards to man and the environment. Nuclear energy, nuclear applications and naturally occurring radioactive material can have an adverse and undesirable impact and IAEA's programmes address this issue at several levels.

The IAEA is actively involved in ensuring the proper operation, closing and decommissioning of nuclear facilities (such as reactors, fuel cycle facilities, mines and ore processing plants) and the proper handling of other radioactive materials, thereby limiting the release of radioactivity into the environment.

Another area of engagement for the IAEA is the proper management of radioactive waste and remediation of contaminated sites. Radioactive contamination of the environment has occurred as a result of both peaceful and military applications of nuclear energy, and needs timely and effective management.

To this end, accurate assessment of radioactive contamination is required while methods/technologies can be made available to Member States to minimize any environmental impact from residues and wastes.

***The Park Grass experiment is a scientific lesson on how to boost productivity and destroy diversity — or how to look for long-term impact and sustainability.***

**An aerial view of the Park Grass Experiment.**
Photo: Rothamsted Research

the positive short-term effect of fertilizers on crop yield, but much less so on the longer-term negative effect these same fertilizers have on species diversity.

According to Keith Goulding, a PGE specialist, the wealth of material accumulated over 150 years has allowed research into some unexpected areas. Some scientists have analysed radioactive elements on the grass samples.

They were able to identify plutonium coming from nuclear tests, and, because of the sensitive equipment used, they could tell exactly which nuclear tests it came from. Further research has included testing for other atmospheric pollutants and examining the impact of climate change on ecology.

In recent years, scientists have noted that plant species on adjacent plots have been evolving, responding to the constraints of a particular soil type. They are looking at evidence of 'genetic bottlenecks' and the impact these have had on diversity.

Scientists agree that the long-term nature of the project makes it impossible to assess where the next discoveries will be. Says Jonathan Silvertown, PGE specialist: "One thing that long-term experiments teach us... is that the longer you study something, the more surprises there are."

These long timescales are essential for understanding future ecological problems. Dr. Goulding agrees: "Short-term experiments are very good for answering specific questions, but if we want to develop truly sustainable systems we need to look at them in the long term."

experiment

The IAEA is also involved in studying the underlying processes that determine the transfer of radioactive material through the environment and the effect of radiation on man and the environment.

## Goal II — Optimizing the overall environmental impact of nuclear technology

The use of nuclear technology in a large number of applications can be pivotal in addressing developmental and environmental needs. However, the environmental advantages and disadvantages of using nuclear applications over non-nuclear technologies also need to be taken into account, and the IAEA's programme addresses this issue too.

At one level, the IAEA facilitates the sustainable use of nuclear power for electricity generation and other applications, including the generation of hydrogen and desalination of sea water. The IAEA, however, also helps assess the overall balance between the negative environmental impact that stems from the use of nuclear technology (such as the use of large volumes of water to cool nuclear power plants, pollution derived from the mining of ores, etc.) versus factors that can be seen as benefiting the environment (e.g., lower emissions of $CO_2$ through the use of nuclear power plants).

## GOAL III — Facilitating the sustainable use and management of natural resources

The IAEA's work seeks to ensure that, when applicable, nuclear techniques are used to improve the management of natural resources and to provide a better scientific understanding of environmental processes.

# IAEA & UNEP: Joining Forces in the Caribbeans

For small islands and coastal countries in the Caribbean region, the exploitation of marine resources can account for as much as 60 per cent of gross national product (GNP). Across the Caribbean, overpopulation and conflicts over coastal land use raise concerns that what goes into the marine environment — domestic and industrial waste — is affecting the quality of marine products and services.

Carried out in collaboration with the United Nations Environment Programme (UNEP), and technical cooperation counterparts from France, Italy and Spain, an IAEA project spanning 2007 to 2010, involving all Member States in the Caribbean region, utilises nuclear technology to address these issues.

As part of the project, entitled *Use of nuclear techniques to address the management problems of coastal zones in the Caribbean region*, scientists use natural radionuclides to examine contaminants in ocean sediments, subtidal and wetland areas. A particular area of focus is the use of radiotracers to follow the trail of contaminants that enter the food chain, potentially threatening the health of local inhabitants and tourists alike.

Along this line, the IAEA works with other agencies in the UN and World Bank Common System in other joint programmes and projects that promote the sustainable management and protection of the environment.

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*In April 2007, the IAEA and the UNEP-CAR/RCU signed a Memorandum of Understanding formalizing collaborative work for the promotion of integrated coastal zone management as well as development and improvement of national and regional capacity to help reduce degradation of the coastal and marine areas of the Wider Caribbean Region.*

*Member States involved in the project include Colombia, Costa Rica, Cuba, the Dominican Republic, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama and Venezuela.*

For example, radioactive and stable isotopes can be used to facilitate the sustainable use and management of natural resources. The use of isotopes can also improve the understanding of natural or manmade systems enabling, amongst other things, the prediction of future global trends from past occurrences, or the global assessment of resources. The number of applications in this area is truly extensive, and the IAEA's programmes relate to this goal through the application of nuclear methods for:

- the monitoring, assessment and protection of air quality;
- reducing the threats to water resources;
- increasing the productivity of land (e.g., for agriculture purposes and for the extraction of raw materials for industry);
- reducing the use of chemicals for agriculture and forestry resources;
- the sustainable generation of energy (e.g., geothermal energy, hydropower, etc.) for electricity;
- improving the prediction and understanding of natural phenomena (e.g., predicting climate change and modelling of carbon fluxes); and
- managing the marine environment.

## Conclusions

Modern society is caught between two urgent demands: to cater to the needs of a growing and aging population, while preserving the earth's resources and its environment for future generations.

At a time when public concern about the environment reaches unprecedented levels, to push back the looming spectres of environmental degradation and climate change requires integrated solutions that tie energy, natural resources and human health.

As part of these solutions, nuclear technologies are crucial components in increasing the world's production of food and energy, as well as in managing existing natural resources with minimum environmental impact. To this end, the IAEA, in collaboration with other partners, has a special role to play in ensuring that the needs of its Member States are met without compromising the future of the Earth and its inhabitants.

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