Nuclear analysis of airborne particles provides a key to alleviating air pollution

A programme of the Regional Cooperative Agreement for Research, Development and Training in Nuclear Science and Technology in Asia and the Pacific (RCA)

Asian haze and global warming are topics that are grabbing the headlines and the attention of not only the politicians and decision makers but also the ordinary person in the street. But the air we breathe is not something confined to our town, city or country. It is circulating globally and what is discharged into the atmosphere can go around the world so what you are breathing in can contain pollutants from many sources and not just those from you neighbourhood. Of growing concern are the tiny particles of matter[1)] pumped into the atmosphere every day by cars, factories and power stations and even by the humble home fire which have been shown to be able to cause serious respiratory problems, cardiovascular damage, lung cancer, and death. They may also be damaging the earth's ecosystems and contributing to climate change.

To fight this problem, the RCA has undertaken an ambitious programme over the past 10 years to introduce and transfer highly sophisticated nuclear and other technologies to countries in Asia and the Pacific to monitor air particulate matter (APM), to identify the sources of origin of the individual minute specks of pollutant, and to 'map' their pathways through the air. Nuclear technologies have provided unique forensic tools that can analyse the microscopic particles of pollutants and unlock the secrets of their origin. Finding the source is the key to eliminating or reducing the pollution. But

if national air pollution policies are to be effective, they will need to complement each other at a regional level too. Thanks to this project, many countries now have acquired these skills and facilities to use nuclear and other advanced techniques. The programme has been funded and implemented under the Technical Cooperation Programme of the International Atomic Energy Agency (IAEA) and in the first four years the United Nations Development Programme (UNDP) also provided financial support for technical equipment and for establishing sampling stations.

The following examples from Bangladesh and the Philippines demonstrate the way in which the technologies are now being used in the region and also the essential links that have been made with the local environmental agencies and government to ensure that practical use is made of the results from this highly sophisticated nuclear technology.

Bangladesh has been producing baseline data on air particulate matter (APM) in the city of Dhaka since the 1990s. The studies identified high levels of lead pollution as well as its possible sources. In response, the Air Pollution Authority introduced new control measures which have succeeded in cutting lead concentrations in APM to about one-third of the previous level.

The Dhaka City Corporation also conducted an urban transport project to improve the city's traffic and to reduce the air pollution from vehicle fumes. Nuclear techniques helped provide the data on APM which was then used by the project authority. The project, funded by the Bangladesh Government and with assistance from the World Bank, proved a great success. Similar projects are being undertaken in other cities such as Chittagong, Rahshahi and Khulna, thanks to the RCA programme. At the national level, the Department of Environment initiated an Air Quality Management Project, with US$ 5 million in funding from the World Bank, to introduce regulatory measures to mitigate the air pollution problem across the whole country.

The Philippine Nuclear Research Institute (PNRI) has participated in the RCA project from the start and has produced the first long-term database (going back to 1997) for fine and coarse particulate matter in Metro Manila. The source apportionment results confirm that vehicular emission has made a significant contribution to air particulates in the area. PNRI data have been reported in the National Air Quality Status Reports prepared by the

Environmental Management Bureau since 2002, as mandated by the Philippine Clean Air Act.

PNRI stations have been co-located with Environmental Management Bureau stations, such as this one (pictured) at Valenzuela City, which together provide complementary data on air pollution. Results showed that the concentration of fine particulate matter was above United States Environmental Protection Agency standards, thus demonstrating the need to establish National Guideline Values. The PNRI has been made a member of the Metro Manila Airshed Governing Board, the area's policy-making body on air quality issues. The PNRI has also provided technical support on air quality monitoring to local governments in, for example, Puerto Princesa, Lipa City and San Pablo City.

This RCA programme has also contributed to major collaborative projects run by international organisations, such as the ASEAN project to reduce haze in the region. Perhaps the most significant of these collaborative projects is the Clean Air Initiative (CAI-Asia), initiated by the Asian Development Bank and the World Bank in 2004. RCA representatives have presented the results of their research at several CAI-Asia symposia.

The RCA programme itself is set to continue another phase over the next two years so that there can be further investments in the long-term local and regional information on air pollution, as well as source fingerprints, to make the region even better prepared to understand and tackle the complex nature and behaviour of air pollution.

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The nose and throat are the body's first line of defence against the air particulate matter (APM) that we breathe in. However when the particles are less than 10 micrometres in diameter (referred to as PM10), they are small enough to bypass the nose and throat and make their way into the bronchi and lungs. If the particles are even smaller (less than 2.5 micrometres, or PM2.5), they can pass through the walls of the lungs themselves and enter other organs, causing cardiovascular problems including heart attacks. In short, the smaller the particle, the more dangerous it tends to be.

Fact Sheet

Nuclear Analytical Techniques

Nuclear techniques such as *ion beam analysis*(*IBA*), *neutron activation analysis*(*NAA*) and *x-ray fluorescence spectroscopy*(*XRF*) are extraordinarily sensitive and highly efficient; their capacity to identify - simultaneously - a wide range of elements quantitatively is unparalleled. For example, a technique known as *particle induced X-ray emission*(*PIXE*), one of the IBA techniques, can recognise in a one milligram sample of APM up to 27 separate elements(including the principal transboundary elements silicon, sulphur and lead): the keys to understanding its local, regional and world-wide sources of origin. PIXE is also very fast: samples require no preparation, and analysis takes only 10 minutes. Nuclear techniques also avoid the uncertainties associated with conventional methods of analysis. Chemical techniques, for example, in which samples are dissolved, can be compromised if a sample fails to dissolve completely, or if the reagents and vessels used in the dissolution process lead to contamination.

Analytical Data Base

Accurate, comprehensive data enables more effective mitigation strategies. Each country that has participated in the RCA programme now has its own database of information collected over the last 10 years, especially for fine (PM2.5-0) and coarse (PM10-2.5) APM. These databases have already been used by many national environmental authorities as a basis for devising new air pollution policies and strategies. Specific measures to reduce the concentrations and impact of particulate pollution include banning lead in petrol, removing old buses from service, and eliminating the use of small two-stroke engines. The effectiveness of these measures has been assessed too. Finally, the databases are used to provide information critical to air pollution models, that is air shed models and advanced receptor models. These models will provide a greater source resolution, better quantification of the source contributions and estimates of the influence of distant, trans-boundary sources on the airborne particle concentrations at the receptor site.

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For Further Information

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