Turning the tide against marine pollution

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

A recently completed RCA project to bring sophisticated hydrological and ecological risk assessment technologies and techniques to countries in Asia and the Pacific has greatly improved the region's capacity both to deal with pollution in coastal waters and to predict and respond to aquatic ecological emergencies. Not only will these new skills assist Member States in their battle to reduce damage to coastal ecosystems, they will contribute to improving the health of local communities who subsist on aquatic foods and to revitalising their fishing and other marine industries.

All too frequently pollutants entering rivers, lakes and oceans are the by-products of human activity, with aquatic environments being used as dumping grounds for waste materials. This problem has been exacerbated in recent decades by the growth of mining and other industries in East Asia and the Pacific. Substantial arsenic deposits, for example, have accumulated in the sediments of the Mekong Delta. But pollution does not arise only from anthropogenic sources. Pollutants also enter the water from natural sources, especially when there are earthquakes and volcanic eruptions or severe climatic or geological events such as cyclones and tsunamis.

BATAN staff inject the radiotracer technetium-99m into a river entering Jakarta Bay. The survey boat follows the technetium tracer as it travels through the water.

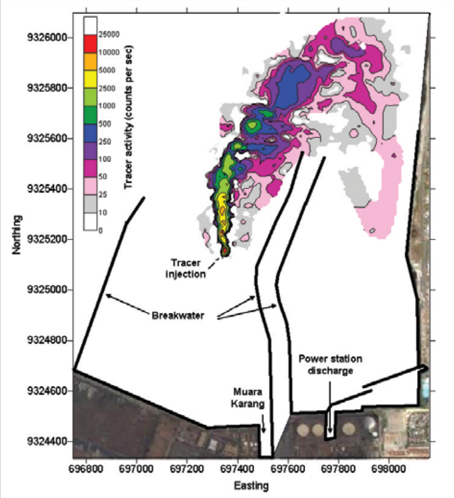
Conventional techniques for tracing pollutants and contaminants are of limited use in the muddy, organic-rich waters typical of the RCA region. This is due to the large background signal from natural fluorescing substances as well as to the rate of dilution and dispersion that occurs with increasing distance from the injection point. Nuclear tracer techniques, on the other hand, are more sensitive, more selective and have greater ease of detection. Highly accurate and specific information on ecological, physical, chemical and biological processes may be obtained by selection of proxy isotopes with the appropriate properties. The nuclear tracers used may be naturally-occurring isotopes characteristic of the particular process under investigation, artificial and introduced as analogues of natural products, or labels on substances retrieved from nature.

Although the winds, tides and currents - Nature's own 'rubbish removers' - disperse many of these water-borne pollutants when they reach the ocean. They are no match for the levels of pollution in evidence today. Populations of fish, seaweed and other aquatic flora and fauna are being decimated, and toxins are entering the food chain. High concentrations of toxins are now found in the water and in aquatic foods which form the staple diets of coastal communities. As well as impairing the health of these communities, toxins damage their economies by contaminating the fish, crustaceans and other aquatic food resources in which they trade.

It became clear that RCA Member States needed to acquire advanced technologies to help in the study of these pollution problems and to assist in improving their capabilities to respond to and manage potential emergencies. Between 2003 and 2006 the RCA therefore ran a project, funded by Australia and implemented through the International Atomic Energy Agency's technical cooperation programme, to provide these technologies and skills.

Through a series of regional training courses and national workshops, local hydrologists and ecologists learnt to use the most advanced conventional and nuclear tools and techniques to sample and analyse the composition, movement and impact of water-borne pollutants and contaminants. With these capabilities they can now accurately determine the severity of pollution in drinking water, the effect of contaminants on aquatic organisms, and the concentration of toxins in aquatic food resources and consequently their suitability for human consumption.

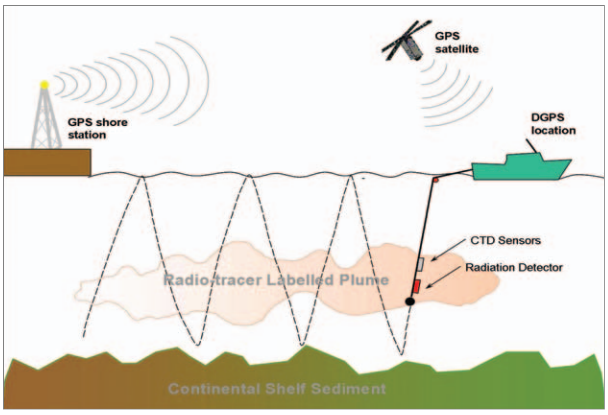
Participating countries also formed their own national project teams which, under the guidance of international experts, conducted local projects to map the movements of pollutants through specific estuarine, coastal lake and riverine environments. From this data, and using probabilistic risk assessment modelling software, they developed computer-simulated models of the local waterways. With these hydrodynamic models they can predict, and respond to, the likely ecological consequences of, for example, the release of an industrial effluent into the ocean, or the construction of a new wharf in a river.



The compiled tracer survey data show the movements of the river as it empties into Jakarta Bay over a 5-hour period.

Finally, in a series of simulated aquatic crises, programme participants were given the challenge of developing emergency response plans to various pollution scenarios. These simulations gave Member States valuable experience in developing fast and effective responses to all kinds of marine emergencies, whether from the spread of algal blooms, the spillage of hazardous chemicals, or contamination by radioactive substances.

As well as disseminating a range of skills and strategies that will serve project participants well into the future, this RCA initiative has generated considerable interest amongst marine research institutes and environmental management agencies. Several of these organisations are now



collaborating with Member States' nuclear agencies, and are learning and applying the isotopic risk and response technologies in their own localities. Skill- and knowledge-sharing networks are beginning to flourish. Thus in the battle against marine pollution, which knows no boundaries, a 'borderless' region-wide response has been set in motion.

As part of this RCA project, a major demonstration of nuclear analytical techniques was undertaken at Jakarta Bay in Indonesia, as a model for other Member States to follow. Jakarta Bay is an ecologically-threatened site, and typical of other bays in the region. Its marine ecosystems have been polluted by industrial activities in the upper catchment and offshore areas as well as by local domestic and commercial activities.

First, a three-dimensional hydrodynamic contaminant transport model and mathematical model of the Bay were developed. Then, a programme of field work was devised, which included a series of radioisotope experiments carried out in specific locations in the Bay. This field work was carried out jointly by Australian and Indonesian teams. The results were then used by experts to validate and calibrate the mathematical model. The outcome is a highly accurate hydrological tool and knowledge-base to assist the local Indonesian agencies in the ongoing environmental management of Jakarta Bay.

The work was carried out by the Indonesian National Project Team with the assistance of experts from the Australian Nuclear Science and Technology Organisation and the University of New South Wales Water Research Laboratory. Integral to the success of the demonstration was the participation also of the Indonesian Nuclear Agency (BATAN) and several key end-users including the Indonesian Institute for Sciences (LIPI) Research Centre for Oceanography, the Bandung Institute of Technology (ITB), and the Jakarta Metropolitan Environmental Management Agency.

Having worked on this demonstration project, the Indonesian Team now has the skills and experience to carry out similar studies and respond to major pollution events elsewhere in Indonesia. They also now act as a regional resource, advising and assisting other Member States carrying out similar studies.

The Jakarta Bay demonstration offers an example of good practice strategy for ecological risk assessment using hydrodynamic model development, model validation using radiotracers, and a contaminant ecotoxicology database specific to organisms native to the region. The strategy and outcomes were disseminated to other RCA countries at a regional training course in China in late 2006.

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For Further Information

RCA Regional Office :

150 Dukjin-dong, Yuseong-gu, Daejeon, Korea 305-353
Telephone : ++82-42-868-2779,8584 Fax : ++82-42-864-1626
Web Site : http://www.rcaro.org
E-mail : rcaro@rcaro.org

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