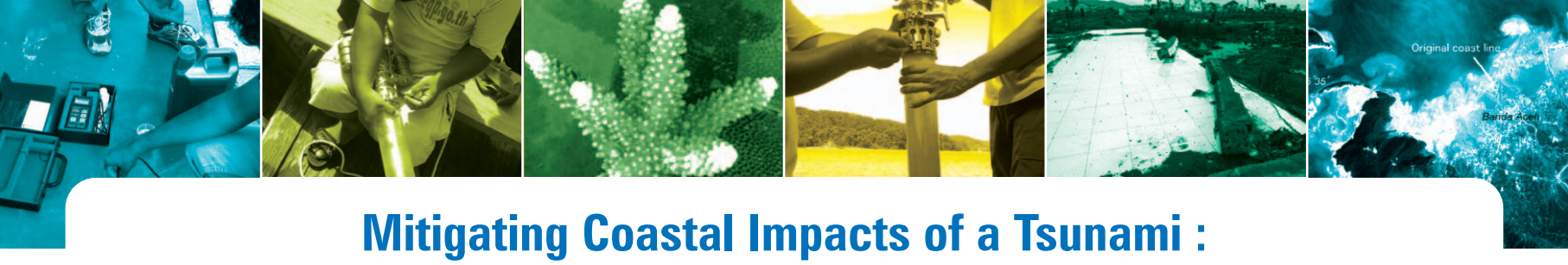



# Mitigating Coastal Impacts of a Tsunami : the Role of Nuclear Technology

The 2004 Boxing Day Tsunami ravaged coastal areas of a number of RCA Member States in Southeast Asia and caused enormous socio-economic damage. Besides the immediate and short-term relief, rescue and restoration operations, the long-term effects of the tsunami also have to be understood. A large-scale ocean tsunami is just one of the chronic natural disasters that can afflict periodically the RCA region and threaten Member States' socio-economic integrity as well as individuals' livelihoods and their health and welfare.

In 2005, in line with international relief actions and responses, and the expressed concerns of RCA Member States, the RCA Regional Office, in collaboration with UNDP, initiated a project entitled "Mitigation of Coastal Impacts of Natural Disasters like Tsunami using Nuclear and Isotopic Techniques". The project was managed by the RCA Regional Office and stands out as a ground breaking achievement on two fronts. It was the first project to apply exclusively Nuclear Analytical Techniques (NATs) to assess the environmental impacts of the 2004 tsunami in selected coastal areas and it was also the first RCA project to be implemented outside of the IAEA Technical Cooperation Programme.

### The aims of the project

- To contribute to the assessment of the environmental impact of tsunami as an input to the integrated coastal management in tsunami-affected areas
- To enhance the utilization and coordination of national analytical capabilities and capacities
- To improve communications, awareness and access to specialized technological solutions for regulators, environmental monitoring agencies and others

Fourteen RCA Member States sharing common interests in the project outcomes participated in the project. The awareness of the activities of other international organizations such as the Coordinating Committee for Geoscience Programmes in East and Southeast Asia (CCOP), the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), and the United Nations / International Strategy for Disaster Reduction (UN/ISDR) were also a great opportunity to enhance regional cooperation and understanding as these organizations also implemented projects in similar or related fields. Overall, the project opened up broader possibilities for potential partnerships between the RCA community and a range of international organizations.

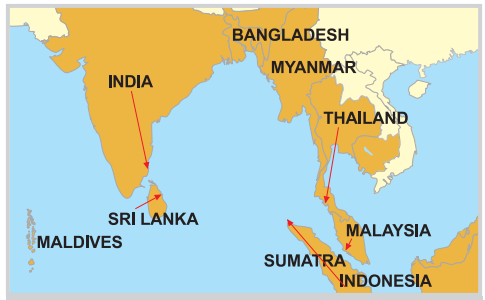
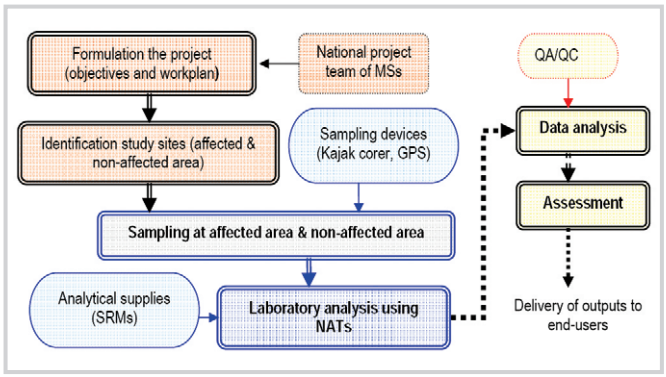



Fig. 1 Locations of sampling sites in the affected countries




The project was implemented with a series of activities shown on the left.

The technical investigations included: analysis of the sediments from core samples; assessment of the groundwater system in tsunami-affected areas; a limited study of the uptake of trace elements in coral and in a mollusc; and, a whole-of-ecosystem ecological risk analysis.

The results showed that, in general, tsunami backwash did not cause any significant increase of toxic metal concentration of the coastal marine sediments although some trace elements were redistributed along the sediment column. Inland waters, wetlands and agricultural land became salinized and the recovery rates of groundwater quality back to pre-tsunami levels were different depending on coastal geography. In the case of toxic materials taken up by marine biota, the coral experiments showed a high degree of bioaccumulation of toxic metals, such as cadmium and zinc, for extended periods.

Fig. 2 Sampling of sediment with Kajak corer

Fig. 3 Radiotracer experiment

Extensive but uneven damage was done to the so-called first line of natural defense mechanisms such as: coral reefs, mangroves, sand dunes and other coastal ecosystems. Many natural and man-made structures were turned into hazardous debris, which in turn became a major threat to public health and safety. Recovery and clean-up of the destroyed area requires a careful and accurate assessment of the environmental impacts of such natural disasters.

The project contributed through a science-based risk assessment process, in particular, to; 1) the decrease of vulnerability to tsunami and other natural disasters; 2) the increased awareness of advantages of the nuclear analytical techniques through repeated interactions with national and regional organizations; and 3) the enhanced capacity of local scientists and technicians on the application of NATs in the RCA Member States which actively engaged in the activities surrounding the post-tsunami environmental assessment. The project also provided some basic information applicable to other projects for end-users in the RCA Member States.

Already the Water Resource Board of Sri Lanka has proposed a national project on the "Trends in Water Quality Deterioration of Northwestern Limestone Aquifer System of the Puttalam District of Sri Lanka". It will apply results and information from the implementation of the tsunami project to the management of ground water resources. Similarly, through participation in the project, Pakistan and other countries which are vulnerable to tsunami events, strengthened infrastructure for sediment core sampling and bio-accumulation studies, and established

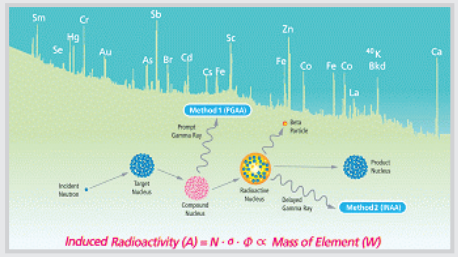
baseline isotopic and chemical inventory on seawater, inter-tidal sediments and coastal ground water for mitigation purposes, in case of any future event along the national coast line.

The project demonstrated as shown by Australia, China, India, Indonesia, New Zealand, Philippines and Sri Lanka that the existing capabilities among Member States on the utilization of nuclear and isotopic techniques can be harnessed in studies related to natural disasters, providing information for coastal managers in reducing risks and mitigating impacts arising from natural disasters such as tsunami, storm surges and typhoons. Additionally the nuclear techniques applied in this project have a great potential for use in studies of sea warming and sea level rise that are predicted as a consequence of changing climate and global warming.

## Nuclear Analytical Techniques

Nuclear Analytical Techniques (NATs) include neutron activation analysis (NAA), particle-induced x-ray fluorescence, energy dispersive x-ray fluorescence, gamma and alpha spectrometry of naturally occurring and fall-out radionuclides, radiotracer methods using artificial and natural radionuclides, as well as $^{18}O$ and $^{2}H$ stable isotope measurements.

NAA allows both qualitative and quantitative assessments of a wide range of elements. Neutron irradiation of samples converts the stable atomic nuclei into radioactive nuclei and enables analysis of the characteristic radiation that is subsequently released identifies the element. Gamma-radiation presents the best characteristics for selective and simultaneous determination of more than 40 elements as shown in the figure on the right.




## Ecotoxicology Study of Coral Reefs by Radiotracer (Impact of sediment-derived contaminants on coral reefs)

The impact of heavy metals on corals is largely unexplored, but potential long-term damage from them includes: reduced photosynthesis (photo-inhibition), loss of algae (bleaching), increased susceptibility to disease, reduced fertility/ reproduction and reduced survival of larvae/juveniles.

Radio-tracer techniques, which have been widely applied to a variety of studies on natural and anthropogenic processes, can be effectively used for research on the bioaccumulation of trace elements in flora and fauna, including corals.

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