Abs. Nr. IT-048

Natural Radioactivity Aspects of the Marine Environment

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Abstract

The oceans of the world, with a spread of 360 million sq.kms and covering nearly two-thirds of the earth's surface, have always played a vital role in the life and continued development of human society. The oceans are host to a diverse variety of resources, such as minerals, oil, gas, chemicals, fisheries, besides providing the maritime link for the increasing global trade and commerce, all of which are crucial to the sustenance and growth of today's technological society. Also in view of its vast potential, the sea is currently being used as a source of fresh water for large communities, by application of modern technology in certain water-parched regions of the world. Another important role played by the oceans is as an ultimate sink for an ever increasing variety and quantities of technological and domestic wastes arising from expanding industrial activities, power generating sources, and growing human settlements around the world. While some of these effluent species, for eg. heavy metals like Pt, Cd have been existing naturally in the marine environment for ages some of the synthetic chemical species like DDT, Dieldrin etc. are alien to the marine ecosystem. In this context it should be realized that radioactivity and ionizing radiations – about which some reservations particularly relating to nuclear power plants exist among sections of public – have always been an inseparable part of the earth's ecosystem including the marine environment since geological times. Anthropogenic sources of radioactivity acting as inputs to the global marine environment are mainly (i) nuclear weapons testing (ii) controlled release of radioactive effluents from nuclear power, nuclear fuel reprocessing facilities radioisotope users etc. However in comparison to the considerable natural

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radioactivities inventory held by the oceans, the man made radioactivity additions to the marine environment, appear to be relatively small. A review of the natural radioactivity distributions in the oceans and their significance, would be of considerable advantage, while attempting to study the impact of man-made radioactivity sources on the marine environment, some aspects of which are discussed in this paper.

<u>*Abs. Nr. IT-057*</u>

Dose Estimates to Public due to Intake of Radionuclides through Consumption of Aquatic Dietary Sources in the Coastal Environment of Kalpakkam

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Abstract

Operation of any nuclear power plant involves release of small quantities of radioactive waste into the environment. In India, such releases are always controlled such that the dose limit to the members of the public as prescribed by Atomic Energy Regulatory Board (AERB) is complied with. Evaluation of releases is carried out by routinely monitoring the environment around the nuclear facility. Different matrices from aquatic and terrestrial environments are collected and analysed for the content of radioactivity and consequent dose in public domain is estimated by Environmental Survey Laboratories (ESLs) located in each nuclear facility.

Kalpakkam (12° 33′ N and 80° 11′ E), located about 65 km south of Chennai city, on the east coast of peninsular India, is a major nuclear complex in the southern part of India which hosts a number of nuclear installations such as Madras Atomic Power Station (MAPS), a Fast Breeder Test Reactor (FBTR), a Centralized Waste Management Facility (CWMF), a Reprocessing and Development Laboratory (RDL), Kalpakkam Reprocessing Plant (KARP) and a host of allied facilities and where many man-made radionuclides are discharged in the environment due to routine radioactive waste releases from different nuclear installations operating at the site. Incidentally, the site is noted for the

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existence of elevated radiation background levels, due to the occurrence of monazite in the coastal beachsands of Kalpakkam. In light of twin aspects of the above, a study of the aspects of public exposures through different environmental pathways, - especially through consumption of different dietary sources - would be worthy of a serious study.

This paper presents the systematic investigations carried out to study the distribution of natural radionuclides like ^{226}Ra, ^{228}Ra, ^{210}Po, ^{210}Pb & $^{238+234}U$ and man-made radionuclides like ^{3}H, ^{137}Cs, ^{90}Sr & ^{131}I in the dietary sources such as fish, crab, prawn, salt and drinking water from the aquatic environment (both marine and fresh water environment) of Kalpakkam.

The natural radionuclides activity concentrations of ^{226}Ra, ^{228}Ra, ^{210}Pb, ^{210}Po and uranium isotopes ranged from 0.3-1,22,641 mBq kg^{-1} fresh/ mBq l^{-1} in all the aquatic samples studied. In general, the mean activity concentrations of radionuclides in different aquatic dietary sources (excluding drinking water) in descending order are: $^{210}Po > ^{210}Pb > ^{228}Ra > ^{226}Ra > ^{238+234}U$.

The observed level of ^{226}Ra activity in aquatic dietary sources (both marine and fresh water), varied from 15-260 mBq kg^{-1} fresh (excluding drinking water), the maximum observed being in the edible portions of prawn sample. It was also observed that food of aquatic origin showed comparatively higher levels of ^{228}Ra activity which ranged from ≤ 110 - 700 mBq kg^{-1} fresh, the maximum being in salt. While ^{210}Pb activity ranged from ≤110 - 870 mBq kg^{-1} fresh in food of aquatic origin, a significantly higher range of ^{210}Po activity level was observed which varied between 801 and 1,22,641 mBq kg^{-1} fresh.

In general, among the aquatic dietary sources, the observed increasing order of ^{226}Ra, ^{228}Ra and ^{210}Pb activities (GM) was as follows: Freshwater fishes < Seawater fishes < Crab < Prawn. However, the observed increasing order of ^{210}Po activity was Freshwater fishes < Seawater fishes < Prawn < Crab.

Among different type of marine fishes analysed, the maximum ^{226}Ra activity of 220 mBq kg^{-1} fresh was observed in the fish *Sardinella* sp. and *Liognathus* sp. was found to accumulate the highest ^{228}Ra activity level ie. 683 mBq kg^{-1} fresh. Among the marine fishes, the observed range of both ^{210}Pb and ^{210}Po activities were 110-870 and 1414-32,260 mBq kg^{-1} fresh respectively. A comparatively lower levels of the distribution of all these radionuclides were observed in fresh water fishes (15-4495 mBq kg^{-1} fresh). Different sources of drinking water were analysed for the content of ^{228}Ra, ^{228}Ra, ^{210}Pb, ^{210}Po and $^{238+234}U$ activities were found to vary in the range of 0.3-24.2 mBq l^{-1}.

In the context of the public exposure significance via. aquatic route, a number of aquatic dietary sources. were collected in all zones unto 30 km radius and investigated for ^{137}Cs and ^{90}Sr activities. The results of these analyses during the period of study ranged 1.0-3487 mBq kg^{-1} fresh / mBq l^{-1}respectively. The close scrutiny of the tabulated data brought out clearly that the measured activity levels of ^{137}Cs and ^{90}Sr in all the matrices studied are low and comparable to pre-operational values. The observed range of tritium in different water sources of Kalpakkam was ≤ 10 – 148 Bq l^{-1} which is very low and environmentally insignificant.

The dose received by members of the public due to intake of natural radionuclides and reactor released / fallout radionuclides through consumption of aquatic dietary sources is computed and compared against each other. The ingestion dose estimates arrived at following extensive surveys at Kalpakkam aquatic environment have shown negligible radiation exposure of members of public resulting from the radioactive liquid effluent discharges into the aquatic environment.

Abs. Nr. IT-106

Remote Sensing of Coastal Ecosystem

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Abstract

Ecosystem is a unit of ecological community, comprised of biological, physical, and chemical components. The coastal ecosystem is the region of highly dynamic, diverse and productive region on the earth due to the combined action of physical features and bio-chemical processes from land and ocean. Coastal habitats perform a variety of important functions within the ecosystem and support the life history and ecology of many species. The shallow estuarine and nearshore habitats (e.g., submerged aquatic vegetation and large woody debris) are structurally complex and dynamic. They are the nursery areas for juveniles and provide food, refuge from predators, spawning habitats, and a transition zone to physiologically adapt to salt water existence. The sediment and morphodynamics of the nearshore region provide basis for foodweb based upon the nutrient supply and detritus produced by plants like marine algae, estuarine and saltmarsh vascular plants, and eelgrass that grow in highly productive shallow water habitats.

Nearshore ecosystem plays a critical role in support of a wide variety of biological resources, many of which are commercially, culturally, aesthetically, and recreationally important to the people of the region. Coastal wetlands act as a buffer to major storm impacts, particularly to damaging storm surges associated with cyclones. Coastal sand areas are an important source of fine aggregate material and beaches are recreational enjoyment, act as breeding, rest and feeding areas for fish, wildlife and waterfowl, and serve as buffer zones in shoreline protection. Recent studies estimate the global economic value of all the services costal wetlands provide to be in excess of $1.6 trillion per year. Coastal wetlands such as brackish water lakes, tidal marshes and mangrove forests,

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occur at the boundaries of land and ocean and because of their unique position in the landscape, they provide many important ecological services that maintain and improve the health of our earth's environment. Tidal marshes and mangroves store flood waters that run off from upland, thereby improving water quality by filtering out sediments and nutrients. They are critical habitat for juvenile and adult stages of many economically important marine fish and shellfish species that spend part of their life in the oceans. They also provide essential habitat for many species of waterfowl and wildlife.

Study of different biological resources and associated geological processes of the coastal zone enhance the understanding of linkage between biotic and non biotic components and their mutual dependence in sustaining the ecosystems integrities. Different Sensors onboard the remote sensing satellites in orbit have provided grater scope in mapping, monitoring and modeling global, regional and local phenomenon like El Nino, global warming, drought, sea level change, cyclone, fronts and gyres, and flood; processes like erosion and sedimentation, upwelling, productivity and pollution etc.; parameters like wave, wind, salinity, sea surface temperature, currents, suspended sediment concentration, chlorophyll etc. In this technical note, applications of remote sensing data in the study of coastal ecosystems are discussed.

<u>*Abs. Nr. IT-107*</u>

Integrated Coastal Zone Management – Case Study (Chennai)

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Abstract

Integrated coastal and Marine Area Management is a concept that facilitates, sustainable management of activities prevalent along the coastal and marine areas and rational utilization of resources available in the coastal land and adjoining sea. The conflicting use of coastal land area and non-mindful of adverse impact of activities on the resources and geomorphology of the coast cause loss of resources and damage to the coastline, thereby affecting socio-economic conditions of the dependent coastal communities. Evolvement of modern scientific tools and techniques like remote sensing, GIS and mathematical modelling has greatly helped in studying the problems caused by the manmade and natural activities in the coastal zone and their impact on the resources as well as on the physiography of the coast. They have helped in addressing the land use changes, changes in the bio-geochemistry of the marine area etc. The paper attempts to demonstrate the use of scientific tools and techniques for the integrated management of the coastal areas using Chennai coast as a case study.

The coastline of Chennai with a hinterland of 40km, from Pulicat lake to Mahabalipuram, harbours a variety of habitats/ecosystem, namely, Pulicat lake, Ennore and Muthukadu creeks, Adyar and Cooum rivers and beaches in the southern part of Chennai. The environment of these areas is widely exposed to several activities like port activities, waste disposal, fishing and recreation, leading to degradation of Pulicat lake, beach erosion at north of Fishing Harbour, accretion at tidal inlets of Pulicat, Ennore Cooum, Adyar and Muthukadu backwaters, waste disposal in city waterways and the conflicting use of coastal

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land, especially in the southern part of the Chennai. Using scientific tools like remote sensing, GIS, mathematical modelling, integrated management solutions have been developed to solve the problems of accretion, erosion, pollution and conflicting use of coastal land.

<u>*Abs. Nr. IT-120*</u>

Radiation Ecology of Gulf of Mannar (South East coast of India)

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Abstract

Gulf of Manner, a marine province in the south east coast of India situated between India and Srilanka along with Longitude from 78^0 08' E to 79^0 30' E and latitude from $8^0$35' N to $9^0$25'N. It runs from Pamban island including Rameswaram, to Kanyakumari to a distance of about 170 nautical miles (315 Km) with an average depth of 12m. The Gulf maintains a rich faunal and floral biodiversity. The study of radioactive substance and radiation in relation to marine environment is felt essential because man depends constantly on living and nonliving resources of the sea. It is therefore considered that a thorough knowledge of radiation ecology is a prerequisite for a judicious utilization of natural resources in our developmental activities. This study is also imperative in view of the forthcoming Kudankulam Atomic Power Project which is also located in the Gulf of Mannar. The radioecological data generated in the fragile and biologically rich Gulf of Mannar would be a useful input as a preoperational data and as a basis to assess the environmental impact of Kudankulam Nuclear Power Project when it becomes operational. Six sampling stations namely Mandapam(S1), Kilakkara(S2), Valinokkam(S3), Tuticorin(S4), Kudankulam(S5) and Cape Comorin(S6) were fixed along the stretch of Gulf of Mannar. Among them S1,S2,S3 and S4 are in coral beds and the station S5 and S6 are rocky in nature. Samples of water, sediment, sea weeds, crustaceans, bivalve molluscs and fish were collected from the respective sampling sites and analysed for Po-210, Pb-210, Ra-226 and Ra-228 based on the method of Iyengar (1983). The ambient gamma radiation levels revealed a rapidly changing non-uniform

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radiation regime ranging from 10 μR/h to 450 μR/h. The study also establishes that the gamma radiation level increases gradually from Mandapam to Cape Comorin. Analysis of the primordial radionuclides (such as K-40, U-238 and Th-232) in the beach sediments of Gulf of Mannar revealed that the ^{232}Th activity is more intense than ^{238}U and ^{40}K. It was also observed that the sampling stations at Kudankulam and Cape Comorin registered a higher levels of these primordial radionuclides than in other stations of Gulf of Mannar. Most of the rivers joining Gulf of Mannar originate in Western Ghats and they deposite considerable amount of Thorium bearing monazite particulates besides weathering of rocks on the shore itself. Also the possible role of coastal water current in carrying monazite from South West coast to South East coast via Indian ocean could not be ruled out. Activity concentration of Po-210, Pb-210, Ra-226 and Ra-228 in Water, Sediment and Biota of Gulf of Mannar are measured. The results showed that Po-210 in water is at a higher concentration (17.7 mBq/l) than its grand daughter Po-210 (11.9 mBq/l). Conversly in the sediment, the levels of Po-210 is higher (87.3 Bq/Kg) than that of Pb-210 (32.0 Bq/kg). However the Ra-228, a derivative of ^{232}Th is always higher in water, sediment and biota. In general the soft tissues of animals tend to accumulate a higher level of Po-210 while the shells of crustaceans and molluscs and bone of fish accumulate more Pb-210. Pb-210 is a bone seeker and tends to replace calcium in shell and bone. Among the shells of animals tested, Crustacean exoskeleton registered a relatively higher level of Po-210 as compared to the shell of molluscan species. This is attributed to its chemical nature. Bivalves molluscan species recorded a highest level of Po-210 ranging from 65.8 to 2668.9 Bq/kg. The sedentary mode of life and feeding on organic particulates which are enriched with Po-210 and non-detoxification are important reasons for such high level of accumulation. The activity concentration of the four radionuclides in the muscle and bone of the fish species are tested. In general the accumulation of radionuclides in muscles, the edible part, is considerably lower as compared to the soft tissues of the invertebrates species. This is a natural safety to fish eating humans. However differential accumulation of radionuclides was observed among the fishes. The analysis of several species of fish revealed that the bottom feeder like the flat fish *Cynoglossus macrostomus* registered higher level of radionuclides tested, as compared to plankton feeder and carnivore feeder. The bottom sediment is the rich source of radioactive substances when compared to water column. Hence, fish feeding on small animals associated with bottom are likely to accumulate higher levels of radionuclides. However, this variability could also be based on bio availability and feeding habits, age, sex and reproductive cycle of the fish.

Abs. Nr. IT-124

Mangrove Community Structure and Evolution at Coringa in the Godavari Delta, Andhra Pradesh

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Abstract

Coringa sanctuary, the second largest mangrove formation on the east coast of India next to Sundarbans has been under considerable human impingement over the last decade. Industrial development along with agriculture practices, oil and natural gas drilling, port expansion episodes and mangrove reclamation to build shrimp farms proved deterrent to the ecosystem. Such effects, not to mention the additional burden of pollution and changes in hydrological regimes caused by freshwater diversion projects, have had an adverse influence on subsistence dwellers in and around Coringa. Reports of mass fish kills in Coringa following release of industrial effluents upstream have become causes of great disquiet recently. As a result of all this, there has been a greater public concern for the protection of Coringa mangrove forest, and an increase in research and management effort. The qualitative degradation of mangroves at Coringa therefore needed comparison with available historical data and between sites differentially affected by man. Under the aegis of European Commission and Government of India Department of Ocean Development funded research, some 228 GPS fixed sites covering an area of 230 km^2 of mangroves were examined (based on PCQM) for a period of 6 years during 1996-'02 and a large amount of data on tree structural variables such as stem density, basal area, relative density, relative dominance, absolute frequency and species individual ranking collected. Altogether 15 species of mangroves (11 major and 4 minor components) represented by 8 families and 10 genera and 6 species of salt marshes consisting of 2 families and 5 genera were encountered in Coringa. There were 10 mangrove associates. Based on multivariate analysis (Bray-Curtis

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similarity and MDS) implemented in PRIMER, the mangrove communities at Coringa could be distinguished into 6 combinations according to their stem density or basal area. These are (1) *Sonneratia apetala* group of trees, (2) *S. caseolaris* and *Avicennia alba*, (3) *Xylocarpus mekongensis*, *Rhizophora mucronata*, *R. apiculata* and *Bruguiera gymnorrhiza*, (4) *Avicennia marina*, *A. officinalis* and *Excoecaria agallocha*, (5) *Lumnitzera racemosa, Ceriops decandra* and *Aegiceras corniculatum* and, (6) *Bruguiera cylindrica*. A further division (based on basal area) of this vegetation into dense (>3.2 m^2/0.1ha), medium dense (3.2-1.7 m^2) and less dense (<1.7 m^2) stands could be made showing significant differences (R: 0.692, P: 0.1%) between sites with high (dense mangroves) and low basal area (less dense) of which the former were located within the (protected) Coringa RF. The findings have shown that mangrove distribution/zonation patterns in Coringa appeared largely determined by geographic location (sea or landward sites), freshwater runoff and the extent of neritic inundation. Superimposed effects could be due to human intervention particularly visible at sites with easy accessibility. Based on changes in mangrove area from 1977 to 1999, the two remarkable causes of mangrove loss in Coringa could be linked to natural events (e.g. coastal erosion, storm impact) and those related to human activities (shrimp culture).