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Study of natural and anthropogenic radionuclides in inter tidal sediments of Kalpakkam coast

V.Sanathanakrishnan*, Anitha Manu, S.Ramkumar, S.Venkataraman, A.G.Hegde
Environmental Survey Laboratory, Health Physics Division, Bhabha Atomic Research Centre,
Kalpakkam - 603 102, Tamil Nadu, (INDIA)

E-mail : santhanakrishnanv@gmail.com

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ABSTRACT

The concentration of the anthropogenic radionuclides ^{137}Cs , ^{90}Sr and $^{239+240}\text{Pu}$ and natural radionuclides ^{226}Ra , ^{228}Ra and ^{40}K were estimated in the inter tidal sediments of Kalpakkam coast. ^{226}Ra , ^{228}Ra and ^{40}K concentrations were in the range ≤ 2.0 to 18 Bq/kg dry, ≤ 4 to 134 Bq/kg dry and 315-582 Bq/kg dry respectively. The higher concentration of ^{228}Ra in the sediments was due to presence of monazite which contains 9.6% of ^{232}Th . The ^{137}Cs and ^{90}Sr levels were below detectable levels. $^{239+240}\text{Pu}$ concentration in the inter tidal sediments were in the range from ≤ 0.007 to 0.1 Bq/kg dry. The $^{239+240}\text{Pu}$ concentration in the inter tidal sediments were low and are comparable to global fallout levels. The study showed that the accumulation of anthropogenic radionuclides in the inter tidal sediments of Kalpakkam is negligible.

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KEYWORDS

^{137}Cs ;

^{90}Sr ;

$^{239+240}\text{Pu}$;

Inter tidal sediments.

INTRODUCTION

At Kalpakkam (12° 33.541' N, 80° 10.406' E), two Pressurized Heavy Water Reactors (PHWRs) of Madras Atomic Power Station (MAPS) of installed capacity 230 MWe each are operating since 1985. Apart from this other nuclear facilities such as a spent fuel reprocessing plant is also in operation at Kalpakkam. Due to the operation of these nuclear facilities, continuous low level radioactive liquid waste discharge into the sea is being carried out. In the sea, inter tidal sediment transport along the coast is occurring. The sediment may sorb the discharged activity besides the inherent natural radioactivity content and

get transported to different distances and depths. In view of this an attempt was made to collect inter tidal sea sediment samples near the discharge area and analyse for anthropogenic radionuclides such ^{137}Cs , ^{90}Sr and $^{239+240}\text{Pu}$ and natural radionuclides such as ^{226}Ra and ^{228}Ra and ^{40}K . The details of the study are described in this paper.

MATERIALS AND METHODS

Study area

Sediment cores at 0.9 km N, 2.2 km N, 26 km NNE, 1.0 km S, 1.92 km S and 18 km SSW with

TABLE 1 : Results of analysis of ^{226}Ra , ^{228}Ra and ^{40}K with depth in sediment cores

Distance from DP	Core section	^{226}Ra Bq/kg dry	^{228}Ra Bq/kg dry	^{40}K Bq/kg dry
0.9 km N	1 – 10 cm	12 ± 0.7	33 ± 1.9	451 ± 17
	11 – 20 cm	6 ± 0.6	24 ± 1.8	392 ± 16
	21 – 30 cm	3 ± 0.4	9 ± 1.2	422 ± 23
	31 – 40 cm	18 ± 0.8	16 ± 1.7	492 ± 16.8
1.92 km N	1 – 10 cm	4 ± 0.6	19 ± 1.8	568 ± 17.2
	11 – 20 cm	3 ± 0.6	15 ± 1.8	533 ± 17.6
	21 – 30 cm	6 ± 0.6	12 ± 1.7	501 ± 16.7
	31 – 40 cm	4 ± 0.6	15 ± 1.7	532 ± 17.5
1.0 km S	1 – 10 cm	5 ± 0.6	16 ± 1.7	436 ± 16.6
	11 – 20 cm	≤ 2	≤ 4	420 ± 16.5
	21 – 30 cm	≤ 2	30 ± 1.9	391 ± 16.4
	31 – 40 cm	4 ± 0.6	20 ± 1.8	582 ± 17.3
2.2 km S	1 – 10 cm	7 ± 0.7	51 ± 2.3	409 ± 18.4
	11 – 20 cm	14 ± 0.8	122 ± 2.9	412 ± 18.8
	21 – 30 cm	9 ± 0.8	134 ± 3.1	441 ± 19.7
	31 – 40 cm	13 ± 0.8	123 ± 2.8	418 ± 17.3
18.0 km SSW	1 – 10 cm	14 ± 0.6	9.6 ± 2.1	315 ± 13.7
	11 – 20 cm	4 ± 0.6	9 ± 1.7	325 ± 17
	21 – 30 cm	≤ 2	≤ 4	332 ± 17.8
	31 – 40 cm	3 ± 0.6	9 ± 1.7	335 ± 16.8
26.0 km NNE	1 – 10 cm	5 ± 0.7	39 ± 2.2	505 ± 18.8
	11 – 20 cm	4 ± 0.6	19 ± 1.9	495 ± 18.6
	21 – 30 cm	7 ± 0.7	25 ± 2.0	405 ± 18
	31 – 40 cm	4 ± 0.6	40 ± 2.2	383 ± 18.2

reference to the low level radioactive liquid waste discharge point were collected from the inter tidal region along the coast.

Sampling

These core samples were collected by hand coring using PVC tubes of diameter 10 cm and height 40cm. At each location two core samples 3m apart from each other were collected. The samples were transported to the laboratory in an ice box and frozen. The sediment cores were then carefully extruded and sliced into 10 cm sections.

The core sections were dried at 110°C for 24 hours in a hot air oven, homogenized and sieved through a 20 mesh (850µm) sieve to remove stones and foreign matter. The content of silt in the sediments was found to be less than 0.5%. These samples thus processed were analyzed for ^{137}Cs , ^{90}Sr , $^{239+240}\text{Pu}$,

TABLE 2 : Result of analysis of $^{239+240}\text{Pu}$ activity in sediment cores (Bq/kg dry)

Distance from DP	0.9 Km N	1.0 km S	1.92 km N	2.2 km S	26.0 km NNE	18.0 km SSW
1 - 10 cm	0.06±0.02	0.04±0.01	0.08±0.02	0.05±0.01	0.04±0.01	0.03±0.01
11 - 20 cm	<0.007	0.05±0.01	0.06±0.02	0.08±0.02	0.03±0.02	0.04±0.01
21 - 30 cm	0.03±0.01	0.03±0.01	0.08±0.04	0.06±0.02	0.03±0.02	0.04±0.01
31 - 40 cm	0.10±0.05	0.05±0.01	0.04±0.02	0.07±0.02	0.04±0.01	0.05±0.02

^{226}Ra , ^{228}Ra and ^{40}K using standard analytical procedures given in the ERL Procedure Manual^[1]. Results of analysis of ^{226}Ra , ^{228}Ra and ^{40}K are given in TABLE 1 and $^{239+240}\text{Pu}$ in TABLE 2.

RESULTS AND DISCUSSION

From TABLE 1 it is observed that value of ^{226}Ra varied from ≤2 to 18 Bq/kg dry, ^{228}Ra varied from ≤4 to 134 Bq/kg dry and ^{40}K varied from 315-582 Bq/kg dry. It is also observed that there is no correlation between the concentrations of ^{226}Ra and ^{228}Ra with depth. The high values of ^{228}Ra in the sediment cores collected at 2.2 km S from the low level radioactive liquid waste discharge (DP) is attributed to the presence of monazite which contains 9.6% ^{232}Th ^[2,3].

^{137}Cs , ^{90}Sr and $^{239+240}\text{Pu}$

In all sediment cores, the ^{137}Cs and ^{90}Sr activities were below ≤1.5 and ≤0.5 Bq/kg dry respectively. During the study $^{239+240}\text{Pu}$ activity in seawater near the sediment core sampling locations was also analyzed and the results were found to be in the range ≤0.01-.1 mBq/l. The activity concentration of plutonium in the sediment cores is given in TABLE 2. In all the sediment cores the ^{238}Pu concentration was ≤0.007 Bq/kg dry.

From TABLE 2 it can be observed that there is only a small variation in $^{239+240}\text{Pu}$ concentration between sediment cores and in between sediment core sections of the same core. Santhanakrishnan^[4] et al have reported $^{239+240}\text{Pu}$ concentration in the off shore sediments up to a distance of 5 km off Kalpakkam coast in the range 0.02-0.2 Bq/kg dry. Bryan^[5] et al have reported ^{137}Cs and $^{239+240}\text{Pu}$ in the intertidal sediments of North Wales in the range of 4.1-16 and 0.7-37.6 Bq/kg dry respectively. ^{137}Cs and $^{239+240}\text{Pu}$ concentrations in the Irish Sea inter tidal flats have been reported to be in the range 18-3986 Bq/kg dry and 4-780 Bq/kg dry re-

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spectively by D.G.Jones^[6] et al. The range of activities reported in this paper are comparable to the values 1.7-4.2, ≤ 0.12 -2.6 and ≤ 0.004 -0.07 Bq/kg dry of ^{137}Cs , ^{90}Sr and $^{239+240}\text{Pu}$ respectively reported by Lee et al.^[7] for the inter tidal sediments of Korea and are comparable with the global fallout activity levels. The low accumulation of $^{239+240}\text{Pu}$ in inter tidal sediments can be attributed to the sandy nature of the sediments with negligible silt content and also due to low concentration of $^{239+240}\text{Pu}$ activity in the seawater.

CONCLUSION

From the study it is revealed that the low level radioactive liquid waste releases from the nuclear facilities in operation at Kalpakkam have not resulted in accumulation of man made radionuclides in coastal sediments of Kalpakkam. These activities of anthropogenic radionuclides are found to be insignificant when compared to the natural radioactivity present in the sediment. The activities of anthropogenic radionuclides in inter tidal sediments of Kalpakkam coast reported in this paper are very low and comparable with the global fallout activity levels.

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