Assessment of Excess Lifetime Cancer Risk in an Endosulfan Spread Area, Kasaragod

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Abstract: *Present study is an attempt to assess the radioactivity level and thereby obtaining the radiological parameters in and around the Rajapuram cashew plantation, an endosulfan spread area, Kasaragod in order to understand the associated health risk to the residents of the area. The external gamma radiation survey has been carried out using a sensitive portable plastic scintillometer (UR-705). The radiological parameters viz. absorbed dose rate (D), annual effective dose rate (indoor & outdoor), and excess lifetime cancer risk (ELCR) were calculated, compared with the reported values elsewhere and possible conclusions are drawn. The values of radiological parameters are well within the permissible limits except the annual effective dose rate (indoor). The study clearly indicates that, the potential carcinogenic effects and the probability of occurrence of cancer to the inhabitance due to gamma radiation exposure is insignificant. The results of these systematic investigations are presented and discussed in detail in the manuscript.*

Key Words: *Endosulfan, Cancer, Gamma Radiation, Kerala, Cashew Plantation.*

Introduction

The issue of naturally occurring radiation becomes relevant during the 1970s as an integral part of radiology. It was soon realized that the radioactive elements are not distributed uniformly in the earth's crust. In terms of dose,the principle radionuclides are ^{232}Th, ^{238}U,and ^{40}K. Both^{232} Th and ^{238}U head series of radionuclides in the soil produce a gamma-beta radiation field in soil that also crosses the soil-air interface to produce exposure to humans. Naturally occurring radionuclides of terrestrial origin are present in various degrees in all media in the environment including the human body. The discovery of cosmic rays and artificial radioactivity has added a new dimension to the studies of radioactivity and ionizing radiation on earth. The challenge has been to identify the effects that naturally occurring radioactive material

may have on daily life and the consequences of the use and the modification in the industrial process.

Between 1976 and 2000, the plantation corporation of Kerala aerially sprayed Endosulfan on cashew plantations covering 11 Gramapanchayaths of Kasaragod district, Kerala. Many health problems were observed in the residents of the area after this aerial spraying. Some of the chronic disorders like neurobehavioral disorders, congenital disorders, cancers, and gynecological abnormalities were more significant only after the cashew plantations started their operations.Various studies have been carried out in this region by different agencies from both government and private, however these studies do not have a common conclusion. The major controversy arose regarding health issues raised in this region is due to endosulfan or not.

A more detailed and systematic investigation is needed to generate data and draw a possible conclusion on the basic dynamics of radioactivity in endosulfan affected areas. Hence, the present study is an attempt to probe the region of Rajapuram, an endosulfan spread area in Kasaragod district. The data collected were carefully analyzed and the results are discussed in the light of literature values reported for other environments.

Materials and Methods

Rajapuram plantation is situated in Panathadi panchayath, Kasaragod District. The location map of the study area is given in the figure.

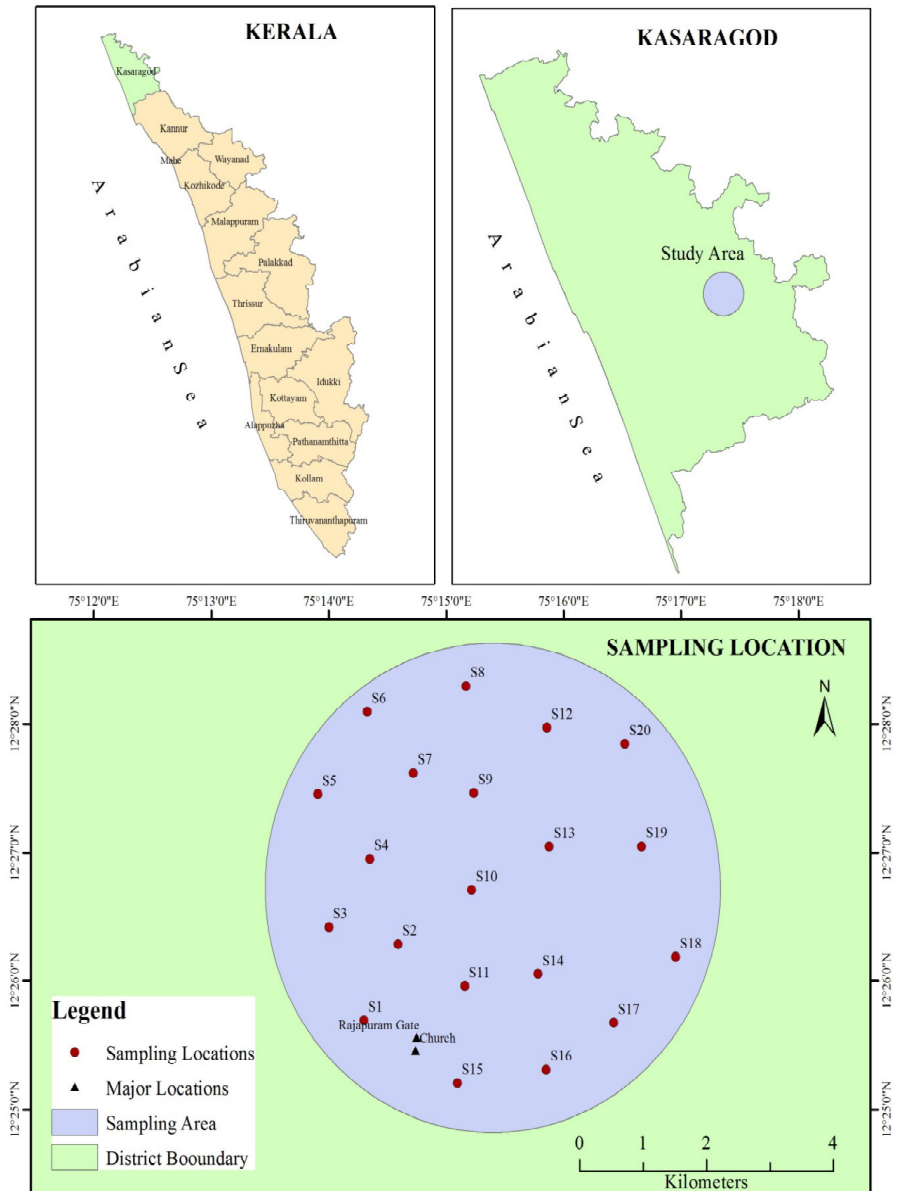
The Micro-R-Survey meter (Type UR-705) manufactured by Nucleonix systemis primarily designed to measure low-level gamma and x-ray radiation. This portable survey meter has a built-in 1inch x 1inch NaI (TI) scintillator with a 1.5 inch PMT to offer optimum performance in counting low-level gamma radiation. The present unit can measure and display the dose rate in the range of 0-1000 $\mu R\ hr^{-1}$ on a dot matrix LCD display.

The ArcGIS is the mapping and analytical platform. Which is the heart of the Esri Geospatial cloud. Cloud platforms and Geographic Information Systems (GIS) software together give the ability to analyze massive amounts of information. Arc GIS offers unique capabilities and flexible licensing for applying location-based analysis to there search works and other educational practices. In the present investigation, Arc GIS software 10.0 version is used for mapping the sampling location.

Absorbed dose rate (D) due to the external terrestrial gamma radiation in the air at 1meter above ground level for the uniform distribution of naturally occurring nuclide was calculated using the conversion factor given below. The exposure rate estimated in μRh^{-1} was converted into absorbed dose rate $nGyh^{-1}$ using the conversion factor.

$1\ \mu R\ h^{-1} = 8.7\ nGyh^{-1}$

LOCATION MAP



The annual effective dose rate is determined by considering the conversion coefficient from absorbed dose in the air to effective dose and the indoor occupancy factor. The estimated average effective dose received by a member is calculated using the conversion factor as 0.7 Sv Gy^{-1} with indoor and outdoor occupancy of 80% and 20% respectively (UNSCEAR, 2000). The annual effective dose rate (indoor and outdoor) is calculated using the following formula (UNSCEAR, 1988).

AEDE = D x 8760h x 0.8 x 0.7 Sv Gy^{-1} x 10^{-6} (indoor)

AEDE = D x 8760h x 0.2 x 0.7 Sv Gy^{-1} x10^{-6} (outdoor)

Where, AEDE is the annual effective dose rate in mSv y^{-1} and D is absorbed dose rate in $nGyh^{-1}$.

The excess lifetime cancer risk is the potential carcinogenic effects that are being estimated from the probability of cancer occurrence in a population of individuals for a specific lifetime from projected intakes (Ramasamy et al., 2013). It is an additional risk of rising cancer due to the exposure to radionuclides incurred over the lifetime of a person. ELCR is calculated following the equation (Prakash et. al., 2017).

ELCR = AEDE × DL × RF

Where, AEDE is the annual effective dose equivalent or whole-body dose (μSv y^{-1}), DL is the duration of life (70 years) and RF is the risk factor (0.05 Sv^{-1}).

Results and Discussion

The absorbed dose rate obtained from the present investigation ranges from 26.1 to 73.95 $nGyh^{1}$ with a mean value of 48.618 $nGyh^{-1}$ and is very less when compared with the world average value of 57 $nGyh^{-1}$ (UNSCEAR, 2000). The indoor annual effective dose varies in the range 0.128 to 0.363 mSv with a mean value of 0.2385 mSv, and the outdoor annual effective dose varies from 0.032 to 0.097 with a mean value of 0.0596 mSv. The mean value of the annual effective dose (indoor and outdoor) is less than the world average value of 0.07mSv (USCEAR, 2000). The excess lifetime cancer risk varies in the range from 0.112 x 10^{-3} to 0.317 x 10^{-3} with a mean value of 0.208 x 10^{-3} and which is very less than the world average value of 0.290 x 10^{-3}. It indicates that cancer-causing effects are not significant in the study area. The comparison study clearly indicates that, the absorbed dose rate obtained from the present investigation is comparable with the values reported for other environs.

Table 1. Comparison of Absorbed Dose Rate with Other Regions

Dose Rate (nGy h^{-1})	Region	Reference
26.1-73.95	Rajapuram	Present study
89	All India average	Nambi et al., (1987)
1644 (43-17400)	Kerala Coast	Shetty et al., (2006)
103 (24-556)	Kalpakkam	Kannan et al., (2002)
2100	Ullal, Karnataka	Radhakrishna et al., (1993)
74	Gudalor	Selvasekharapandian et al., (2000)
87-174	Kudamkulam, India	Lakshmi et al., (1989)
140	Shimoga, India	Anandaram et al., (1998)
200-3000	Neendakara, Kerala	Sunta et al., (1993)
57 (18-93)	World Average	UNSCEAR (2000)
56 (20-100)	Indian Average	UNSCEAR (2000)

Conclusion

The observed high activity concentration of radionuclides might be related to increase in cancerous injuries and birth defects recently reported. The radiological parameter values obtained were well within the permissible limits except for the indoor annual effective dose,which was found to be slightly higher. The results of excess life time cancer risk indicates that, carcinogen levels are not significant in the Rajapuram region and hence the risk of developing cancer and birth issues by the radionuclide exposure will be low.

Reference

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