

Measurement of Radioactive Hazards in Palar River Sediments through grain size and Magnetic Separation

**Submitted in partial fulfillment of the requirements for the award of Master of
Science degree in Physics**

By

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DEPARTMENT OF PHYSICS

SCHOOL OF SCIENCE AND HUMANITIES

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade “A” by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **SHREE GOWRI. M (40590006)** who carried out the project entitled **"Measurement of radioactive hazards in Palar River sediments through grain size and magnetic separation"** under my supervision from **NOVEMBER 2021 TO MAY 2022.**

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DECLARATION

I **SHREE GOWRI. M(40590006)** hereby declare that the Project Report entitled “**Measurement of radioactive hazards in Palar River sediments through grain size and magnetic separation**” done under the guidance of **Dr. S. Murugesan** is submitted in partial fulfillment of the requirements for the award of Master of Science degree in Physics.



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ABSTRACT

Palar is one of the major rivers in Tamil Nadu, India. River sand is an important component used for construction of buildings in India, and it is essential for irrigation, drinking water, and electricity. A gamma ray spectrometer with Thallium activated NaI (TI) detector is used to investigate the isotopes of uranium, thorium, and potassium (^{238}U , ^{232}Th , ^{40}K). Bigger than 125 μm in size and non-magnetic grains were separated with the help of ASTM standard sieve and strong electromagnet.

The systematic studies are carried out for the measurement of radioactive hazards in Palar River sediments through grain size and magnetic separation. The sand samples are collected and dried at 100°C for 24 hours. Then it is packed and sealed in a container. The analysis of uranium, thorium, and potassium concentration of sediments was studied using NaI(TI) detector. Using certain formulas AEDE, ELCR, RHP, H_{in} , H_{ex} , Ra_{equ} , AUI, Alpha, and gamma were calculated.

The following radiological parameters are examined. Absorbed dose (AD_{in} and AD_{out}), annual effective dose equivalent ($AEDE_{\text{in}}$ and $AEDE_{\text{out}}$), and hazard indices for calculating human radiation exposure, such as average radium equivalent (Ra_{equ}), external (H_{ex}), and internal (H_{in}) hazard indices are computed and correlated. Radioactive heat production (RHP), internal and external Excessive Lifetime Cancer Risk ($ELCR_{\text{in}}$ and $ELCR_{\text{out}}$), Alpha (I_{α}), Gamma Index (I_{γ}), and Activity Utilization Index are all factors in the calculations. The varied parameter values for both magnetic and nonmagnetic samples suggest that the Palar River does not pose a radiation concern, and cancer risk is lower than the world average, with the exception of site P7 for the sediment samples greater 125 microns in size. AEDE, ELCR, RHP, H_{in} , H_{ex} , Ra_{equ} , AUI, Alpha, and Gamma all have lower values than the world average. This analysis shows that almost all radioactive parameters are under control by comparing the findings to the worldwide average. However, with the exception of Site P7 (>125) in Palar River offers a radioactive threat.

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LIST OF ABBREVIATIONS

AD	- ABSORBED DOSE RATE
IN	- INDOOR
OUT	- OUTDOOR
TOT	- TOTAL
AEDE	- ANNUAL EFFECTIVE DOSE EQUIVALENT
ELCR	- EXCESSIVE LIFETIME CANCER RISK
H	- HAZARD INDEX
AUI	- ACTIVITY UTILISATION INDEX
RHP	- RADIOACTIVE HEAT PRODUCTION
ASTM	- AMERICAN SOCIETY FOR TESTING AND MATERIALS
Ra_{equ}	- RADIUM EQUIVALENT
I_α	- ALPHA INDEX
I_γ	- GAMMA INDEX
U	- URANIUM
TH	- THORIUM
K	- POTASSIUM
NaI (TI)	- SODIUM IODIDE THALLIUM DETECTOR
IPCD	- LITRES PER CAPITA PER DAY
MCM	- MILLION CUBIC METERS
ERDM	- ENVIRONMENTAL RADON DAUGHTER MONITOR

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CHAPTER 1

1.1 INTRODUCTION:

Rivers play a significant part in evaluating the earth's surface by eroding and depositing sediments on the surface. They are superior to any other geological agent in terms of their ability to sculpt the earth's surface. It is possible that the apparent observation of a River will not be spectacular. However, a detailed examination in the context of time exposes their enormous amount of effort as well as their ability to produce gradations. Rivers flow from one level of elevation to another level of elevation. Local circumstances dictate the flow direction, although it can go in any direction. It erodes the walls and floors as it moves forward, accumulating materials along the way. Weathering and bulk waste are included in the load as a source of material. According to the current analysis, the River sands are also at risk of radionuclides. River sand is extracted from the banks of Rivers or Riverbeds. As the sand in Rivers erodes into one another, the granules become thinner and more rounded. River sand has a colour that can be described as nearly white. River sand is a popular choice due to the great variety of uses and the ease with which it can be obtained. When dealing with radioactive soil, this is an important consideration to keep in mind. Soil contains minerals, organic matter, organisms, and gas. Soil minerals such as clay, silt, loam and sand contribute to the texture of the soil. As an example, we use sand rather than other building materials in these sorts. The three most frequent radioactive elements on Earth are uranium (U), thorium (Th), and potassium (K). As a result of this investigation, we can examine the radiation properties of Palar River.

1.2 THE PALAR RIVER – STUDY AREA:

The Palar River is one of the most important Rivers in India which flows through the Palar River Valley. An investigation of the Palar River basin in the Vellore district discovered that it was contaminated with heavy metals, mainly chromium and salts, according to the inferences of the study. The Palar River serves as a source of drinking water and irrigation for 30 towns and 50 villages that are located along its course. Effluents from the tanneries on the banks of the Palar River were permitted to enter the River, which is now contaminated and unfit for drinking or agricultural use. Because of pollution, thousands acres of productive land have been turned into

wasteland and are no longer suitable for farming. Ranipet, an industrial region located on the Palar River's bank, was named as one of the world's most polluted areas in 2006 (World's Worst Polluted Places-the Top Ten, September 2006), according to the World's Worst Polluted Places-the Top Ten report. Metals contamination is one of the most serious environmental hazards in many countries, and these contaminants are primarily caused by a variety of industries such as leather, agriculture, textiles, and other similar businesses (**Ganguli et al, 2002**). In these locations, the most typically found metals are lead, chromium, arsenic, zinc, cadmium, copper, and mercury, with lead being the most prevalent. These metals may pose a substantial threat to human health and ecological systems if they are found in groundwater and soils at high concentrations (**Evanko et al, 1997**). A radioactive substance can be found in groundwater and other drinking water sources, which many people are not aware of (radionuclides). As a result of their toxicity or carcinogenicity to humans, several radionuclides present in water can be a health danger to people. Using radionuclides other than Cesium, it is possible to determine the presence of groundwater in an aquifer or silt at the bottom of a water body. Nuclides are found in a wide variety of rocks and minerals. Uranium is one of the radionuclides that has existed since the beginning of time. Others, like as radon and radium, are by-products of the first radionuclide's breakdown and are therefore classified as radioactive waste. Consequently, these radionuclides can be found in large quantities in groundwater sources. Because naturally existing radioactive elements emit alpha particles as part of their decay process, the total amount of radioactivity in water is referred to as "gross alpha". When radioactive elements decay, they emit large amounts of alpha radiation. To assess the age of groundwater and sediment, radionuclides can be employed in combination with other methods. Water or sediment has been in contact with the atmosphere over an extended period of time. We can use this to determine how long groundwater has been in the aquifer since it was refilled with water. The age of the groundwater supply can determine how those contaminants are likely to be present in groundwater and how long it will take for contaminants to be transferred down the aquifer. Using bed sediment to determine its age, we may determine when it was deposited. This information can be used to help recreate contamination histories in sediment cores, if available. The radionuclides used as age tracers are derived from the atmosphere. A few of them are "cosmogenic," meaning that they are caused by

cosmic rays from stars (including our sun) striking the Earth's atmosphere. Because the rate of decay of these radionuclides is known, the activity of these radionuclides in water or sediment can be used to compute the amount of time that has elapsed since the water or sediment first came into contact with the surrounding environment. It is possible to obtain age information from "ancient" groundwater by using cosmogenic radionuclides with long half-lives, such as Helium-4. Some short-lived radionuclides such as Beryllium-7 can be used to determine the age of water and soil by measuring their decay rates. Since Humans are responsible for the production of radionuclides through nuclear weapons testing, nuclear facility emissions, and waste. A nuclear weapon detonated in the 1950s and 1960s produced tritium (H-3), and the presence of tritium in groundwater shows that it is only a few decades old (60 years or less). As of right now, we can know that the River sands pose a risk of radioactive contamination. River sand is gathered from Riverbanks or Riverbeds for use in construction. River sand contains fine rounded granules as a result of mutual degradation produced by the impact of the flowing water on the sand grains. The colour of River sand is almost completely white. River sand is widely utilised for a number of purposes since it is usually available in a clean state and may be easily obtained. We have to take this into consideration because we are dealing with radioactive compounds in the soil at the moment. Minerals, organic materials, organisms, and gas are all found in soil, making it a five-element system. The three sizes of soil minerals are clay, silt, and sand in which the percentage of particles in each size class reflects the texture of the soil. Instead of using other materials, we employ sand in these sorts, which is primarily used for construction. On Earth, the most abundant radioactive elements are uranium (U), thorium (Th), and potassium (K). According to the findings of our study, the Palar River was examined. The study's aim is to determine a solution for River sand that contains radionuclides and to do so in a safe and environmentally friendly manner. In today's world, one of the most serious problems with regard to air pollution is the fact that the environmental gamma radiation emitted by many radioisotopes present in the natural radioactive decay series of uranium, thorium, and actinium as well as the naturally occurring radioisotopes Potassium-40 and Carbon-14 generates gamma radiation. In all types of rocks and soil, as well as in our food and drinking water, these contaminants can be found. Soil is one of the most critical components for the existence of all organisms on the planet. The soil is composed of organic,

inorganic, and metal components that have been accumulated as a result of human activity. The soil has an important function in the survival of humans. When certain pollutants are released into the environment, they can be extremely harmful to human health and have a negative impact on the fluvial system, which is a system dominated by Rivers and streams and which also affects soil that is bound by Rivers. A portion of the radioactivity of some sedimentary rocks can be related to uranium and potassium's tendency for binding to organic components, as opposed to thorium and potassium's preference for attaching to clays. As a result of the growth in construction activity, the demand for River sand is increasing at an exponential rate. The impact of continual excavation has resulted in catastrophic changes in environmental issues such as Riverbank sliding and a decline in the groundwater level. Earth's radioactive substances are produced by the elements Uranium, Potassium, Radium, Radon, and Thorium, as well as by the elements soil, water, and flora. To investigate radioactive materials such as Uranium, Thorium, and Potassium, we employ a Gamma Ray Spectrometer equipped with a NaI(Tl) detector. An investigation into and correlation between radioactive risks and magnetic features as well as heavy metals in River sand is the purpose of this research. The goal of this research is to strengthen environmental regulatory systems while also providing knowledge on the geological characteristics and formation of the materials under investigation. Most of the land's surface is covered by a thin layer of soil. It is made up of both inorganic and organic components. A plant's foundation is the soil, which also serves as a reservoir for water and nutrients. In terms of chemical and physical qualities, soils are vastly different. Soil types are created by a variety of processes, including leaching, weathering, and microbial activity. There are distinct advantages and disadvantages to each variety for agricultural output. As we can see and feel, soil's physical features which encompasses everything we can see and touch. The features include texture, structure, porosity, colour, depth (the space between the particles) and the amount of stone in it. Soil and plant health are aided by a well-structured soil, which allows water and air to pass through it. Plants and animals rely on soil for water storage, as well as for the movement of machinery and animals. Despite the fact that some soils are naturally more structured than others, some physical properties of soils can be altered with proper management. Observing the physical properties of soil is essential to determining the state of the soil. Additionally, it is crucial that

management approaches do not contribute to soil degradation. Compaction is an example of this, as it minimises the number of macro pores, or spaces between combinations. Compaction is an example of this, as it minimises the number of macro pores, or spaces between combinations. This means that less air and water can get into and through the soil as a result. The proportional quantities of inorganic particles of various sizes affect a great deal of the soil's texture. The inorganic fraction of soils is described using the following sizes: Particles larger than 2 mm in diameter are known as gravel. Sand with a diameter of less than 2 millimetres and greater than 0.2 millimetres is considered coarse. Sand that is less than 0.02 millimetres in diameter is known as "fine." silt (particles less than 2 micrometres in diameter) Particles smaller than 0.002 mm in diameter are known as clay.

1.2.1 SAND

Quartz is the most common mineral in soil sand. Compared to silt and clay, sand particles have a tiny surface area per unit weight, little water retention, and little chemical activity. Sand is a naturally occurring inorganic substance composed of powdered rocks that occurs in large quantities in nature. It is of utmost relevance in our everyday lives because it is considered to be one of the requirements for the development of infrastructures. Pit sand is a coarse sand that is typically found in a reddish-orange tint and is used in construction. It is protected by deep holes sunk one to two metres below the surface of the land. Pit sand grains are rough, angular, sharp, and harsh in appearance. It is a preferred alternative for concrete building because it is free of salts and other impurities. River sand is a sort of fine sand that is created by corrosion caused by water currents and can be found in River streams and on River banks. It is typically a white-grey colour. River sand, in contrast to pit sand, has grains that are smooth, rounded, and of high quality. As a result, it is widely used throughout the world for a variety of construction uses, including plastering. Sea sand (also known as offshore sand) is a type of sand that has been worn by the sea. It is obtained from seashores and is distinguished by its distinctive brown colour. Its grains are exceptionally fine in quality and have a circular form, which is characteristic of sea sand. Sea sand is composed of salt and other marine pollutants that have the ability to collect moisture from the atmosphere and release it as dampness. As a result, it is avoided in the construction of concrete structures and technical processes. Manufactured sand is a form of sand that is created by

crushing hard granite stones. It is used as an alternative to River sand in the building industry because of its high strength. When prepared with the required gradation of fineness, shape, surface smoothness, texture, and consistency, it is the best sand for construction. By preventing isolation during setup, bleeding, cracks, gaps, and capillary formation, it makes concrete stronger. It's the best sand for building, and it makes concrete stronger. Furthermore, its use helps to avoid disasters such as groundwater depletion, water scarcity, and a threat to bridge safety by preventing the dredging of River beds to get River sand, making it a more environmentally friendly option to other sands.

1.2.2 CLAY:

The surface area of clays is enormous when compared to the surface areas of the other inorganic components. Thus, clays are highly reactive and capable of retaining nutrients on their surfaces due to the high chemical activity. Plants can take use of these nutrients by releasing them into the soil's water supply. When water comes into contact with clay, it might be difficult for plants to take advantage of it. Clay comes in a variety of forms. As well as their sticky nature, clays are distinct from sand and silt because they may swell and retain the shape, they were created in. In terms of size, clay particles are the smallest of all soil particles, measuring less than 0.002 mm in diameter. It is made up of microscopic and sub-microscopic particles that have formed as a result of the chemical disintegration of rocks and other minerals. Clay is a fine-grained cohesive soil with a high degree of cohesiveness. When they are wet or dry, they quickly observe to one another and generate a sticky or gluey surface texture. Clay is composed of more than 25% clay, and because of the gaps between clay particles, clay soils are capable of retaining a significant amount of water. When clay comes into contact with water, it expands, and when it comes into contact with air, it shrinks. The clay particles are thin and flat in comparison to sand particles, which are normally spherical. They are also covered with microscopic plates. Because of its qualities, organic clay is used in construction as cement. It has a high compressibility and strength when dry. This soil type is a blend of clay, sand, and silt that benefits from the characteristics of the three various textures. It is particularly good at retaining water and promoting air circulation, drainage, and fertility. These soils are rich in nutrients, are easy to deal

with, and have excellent drainage. They can be classified as either sandy or clay loam depending on the prevailing composition of the soil.

1.2.3 LOAM:

The loam is formed by the way the other particles in the soil combine to form a cohesive whole. Soil that contains 30% clay, 50% sand, and 20% silt is classified as a sandy clay loam, with the soil types written before "loam" in the order that their particles are most dominant within the loam (for example, 30% clay, 50% sand, and 20% silt). It is common to hear the terms "clay loam," "silt loam," and "sand loam" used to refer to soils that are mostly made of the various ingredients listed above.

1.2.4 SILT:

Silt is a sediment material with an intermediate size between sand and clay. Carried by water during flood it forms a fertile deposit on valleys floor. The particle size of silt ranges from 0.002 and 0.06 mm and it is a non-plastic or low plasticity material. Due to its fineness, when wet it becomes a smooth mud that we can form easily into balls or other shapes in wet hand and when silt soil is very wet, it blends seamlessly with water to form fine, runny puddles of mud. Sieved silt comes somewhere in between sand and clay in terms of particle size. It creates a fertile deposit that floodwater carries away. For the most part, sludge has particles that range in size from less than 0.002 mm to less than 0.06 mm. Water erosion is more likely to occur in areas with silty or sandy soils, particularly in areas with heavy rainfall and steep terrain. Short channels, or "rills," can be formed in regions prone to erosion following severe rains. Surface runoff occurs when rainfall is so heavy that the water cannot penetrate the soil. Livestock management can also have an impact on erosion and runoff in grasslands. In wet conditions, high numbers of livestock may increase the risk of runoff by poaching and compacting the topsoil. Depending on the method of cultivation, some crops are more susceptible to water erosion than others. This is the most vulnerable land which is used while harvesting forage corn and field vegetables in the fall in poor soil conditions. Permanent grazing and long-term grassland management pose few risks. In comparison to barren ground or soils with fine seedbeds, cropped soils are much more resistant to disease. By lowering compaction and increasing organic matter in the soil, as well as using green manures and planting buffer strips, as well as building grass lanes

and buffer strips, vulnerable fields can be protected against soil erosion. Sandstone is possibly the most well-known of all rocks, maybe because it is the most easily mined and because it has been utilised for architectural purposes more than any other type of natural stone. The grains of sand in a piece of sandstone, when examined closely and with a lens if necessary, are found to be identical in appearance to those mixed up by the breaking waves on a beach when the stone is examined closely and with a lens. While the vast majority of the grains are made up of more or less spherical grains of quartz, there are also some made up of hazy, weathered-looking feldspar, and there are occasionally a few dazzling spangles of mica to be seen. The elements used to create sandstone are clearly reclaimed; they are weathered pieces obtained from the breakdown of an older rock type such as granite, which contained the same minerals as the sandstone. The only way it varies from deposits of current sands is that it is cohesive rather than loose. Calcite is a typical cementing substance that is used in construction. Limonite and red variants of haematite are used to bond brown sandstones together. Sandstones that are white and exceedingly hard contain silica cement, which has crystallised to form quartz. It is believed that these cementing elements were formed between the grains of sand by groundwater that percolated through the sand when it was buried beneath subsequent layers of sand or other formations. It is commonly referred to as quartzite when the white siliceous sandstone is composed primarily of quartz grains, which also contains a significant amount of cement. During the course of an erosional process, however, there may not be enough time or the climate may be unsuitable for all of the feldspar to be weathered into clay minerals before the disintegrated fragments is deposited again, resulting in a high concentration of feldspar grains (typically pinkish orthoclase or microcline) in the resulting sands. Arkose is a name used to describe sandstones that are high in feldspar. Another major variety of sandstone is known as graywacke, which is a term that translates as 'grey grit' and was given to it by miners in the Harz Mountains before being adopted by Werner himself. When compared to conventional sandstone, graywacke varies in two ways: (a) its grains are less well sorted, i.e. they are of widely varying sizes; and (b) it contains a greater range of elements such as grains, matrix, and cement. There may be a variety of minerals in its grain structure, including quartz, feldspar, and mica, as well as particles of incompletely weathered ferromagnesian minerals and fragments of rocks from the region that was undergoing erosion, which

may include volcanic types in some regions. The matrix is fine-grained and mostly formed of flaky alteration products of weathering, including as clay, micaceous, and Chloritic minerals, which are present in significant amounts. Graywackes are muddy grits of a type that can only have accumulated as a result of quick transit from a place with a variety of rocks and strong erosion, as evidenced by their presence.

CHAPTER 2

LOCATION, GEOLOGY AND SAMPLE COLLECTION

2.1 GEOGRAPHICAL AND PHYSICAL FEATURES OF PALAR RIVER:

The Palar River Basin is one of Tamil Nadu major River basins. The main Palar River begins in Nandhi Durg, Kolar district, at an elevation of 800 metres above mean sea level in eastern Karnataka, and flows through Kolar and Bangarupet Taluks, eventually forming the massive Bethamangal tank, which serves as the primary source of water for Kolar Gold Field and Bharath Earth Movers Limited. It flows through Andhra Pradesh for a short distance through Kuppam Taluk in Chittoor District before entering Vellore District of Tamil Nadu and flowing into the Bay of Bengal west of Vaniambadi Town, east of Maduranthagam, and south of Mahabalipuram. The Palar River Basin covers a total area of 17,633.19 square kilometres, with 3,123 square kilometres in Karnataka, 4,267 square kilometres in Andhra Pradesh, and 10273.19 square kilometres in Tamil Nadu. From east to west, it is located between 78°24'43" E, 12°36'26" N and 80°09'54" E, 12°31'26" N, and from north to south, it is located between 79° 14'23"E, 13°10'21" N and 78°41'51" E, 12°14'05" N. Figure depicts the Index map. Andhra Pradesh state borders the basin on the northwest, Chennai River Basin on the northeast, Penniayar River Basin on the southwest, and Varahanadhi River Basin on the northeast. Figure depicts the basic map. Andhra Pradesh state borders the basin on the northwest, the Chennai River Basin on the northeast, the Penniayar River Basin on the southwest, and the Varahanadhi River Basin on the northeast. Figure depicts the basic map.

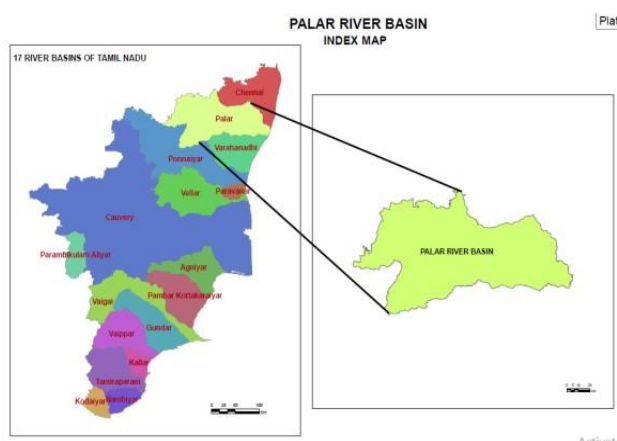


FIG 2.1: Palar River map

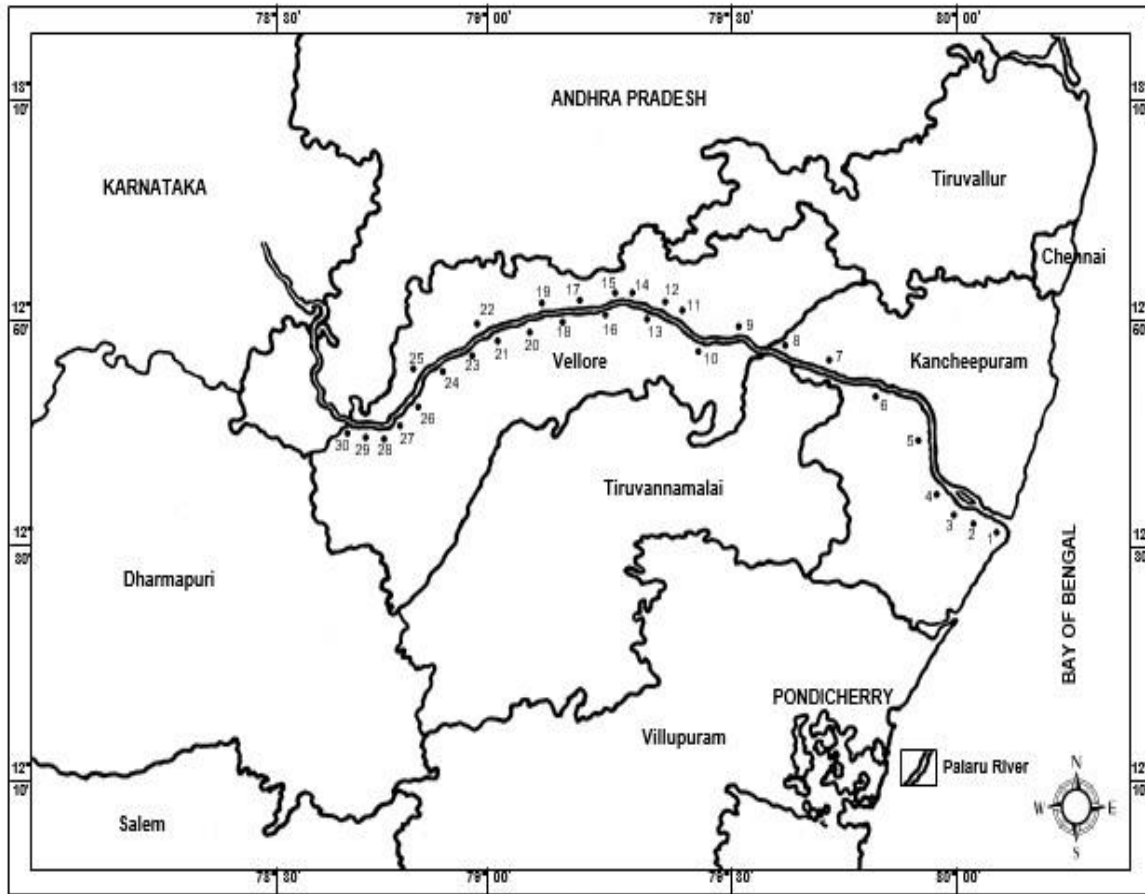


FIG 1.2: Location of Palar River

The basin includes the Tamil Nadu districts of Vellore, Thiruvannamalai, Kanchipuram, Thiruvallur, Villupuram, and Krishnagiri. Meanwhile the major tributaries are 1. Ponnai 2.Kaudinya Nadhi 3.Malattar 4. Cheyyar 5.Agaramar 6.Kamandalar 7.Naganadhiar 8.Killiyar 9.Vegavathiar are. There are 50 blocks in this basin that fall partially or completely into the above districts. The Vellore district in Tamil Nadu is located between 12° 15' and 13° 15' North latitudes and 78° 20' to 79° 50' East longitudes. This region covers a total size of 6077 square kilometres. According to the 2011 Census, the total population is 39, 36,331. The River Palar runs through the Vellore district. Andhra Pradesh state borders the district on the north, Krishnagiri District on the west, Kanchipuram District on the east, and Thiruvannamalai District on the south.

The District is divided into three divisions and thirteen Taluks, as follows:

2.1.1 DIVISIONS:

1. Vellore
2. Tirupathur
3. Ranipet

2.1.2 TALUKS:

1. Vellore
2. Katpadi
3. Gudiyattam
4. Anaicut
5. Pernambut
6. Arakkonam
7. Walaja
8. Arcot
9. Nemili
10. Tirupattur
11. Vaniyambadi
12. Ambur
13. Natrampalli

2.2 LAND UTILISATION PATTERN:

The Vellore District has the most land use, with cropland and plantation type land covers, followed by forest cover, and so on, out of a total area of 6077 sq. km. The Vellore district is a big part of the Palar River basin. The main River in the region is the 295-kilometer Palar River, which drains the area. It follows the Eastern Ghats hill ranges for the majority of its length. Although it is dry for the majority of the year, the lower levels have a vast flood plain. Four of Palar's major tributaries drain the district: Ponnaiyar, Cheyyar, Pambar, and Malattar (all of Palar). Streams are generally managed architecturally because of their transient nature. For centuries, Chennai and its surrounding areas relied on the Palar River, which is the longest of the three Rivers encircling the city. The Palar and its tributaries irrigate around

300,000 hectares of agricultural land in Kanchipuram, Thiruvallur, Chennai, and Vellore districts. Surface water samples taken from the Palar River show that the pH, Electrical Conductivity, Total Hardness, Chloride, and Coliform values are all within acceptable levels. In places like the Koudanaya River, Nandhiyalam village, Rajakal head sluice, Mottur village, and the stretch between Ranipet and Walajah, dissolved oxygen levels dropped below 5 mg/lit due to the mixing of Tannery effluent with water. This has an effect on the local aquaculture market. The River water has become tainted by human waste. Total Dissolved Solids (TDS) concentrations were found to be excessive in areas polluted by tanneries. It is safe to say that chloride levels are over bearable levels, but lower than permitted. BOD is abnormally high in some headworks, with a range of total hardness well over and below the tolerated limit.

2.3 SAMPLE COLLECTION:

To assess natural radioactivity in soil, surface soil samples are randomly obtained from the study region. The locations are carefully chosen to avoid surface runoff during heavy rain. The sediment samples are obtained from 30 successive locations (P1 to P30) in Palar River (Table 2.1). Each place is separated by a distance of 15 kilometres approximately in Palar River. The recently excavated sediment samples were manually collected from Palar River with the use of a plastic spade in polyethylene bags during the period from upper surface (0–5 cm) of the River. Each sample has the weight of roughly 2 kg. During the sampling process, 500 g in each samples are taken and used. The samples are taken and dried in the open air at room temperature.

Table 2. 1: Latitude and Longitudinal Coordinates of Palar River

S.No.	Location	Latitude	Longitude
1	Sadras	12°31'60N	80°09'60E
2	Paandoor	12°58'60N	79°58'00E
3	Paalur	12°55'60N	79°40'00E
4	Maduranthagam	12°46'00N	79°31'60E
5	Chengalpattu	12°42'60N	80°01'00E
6	Valajabath	12°55'60N	79°22'60E
7	Kanchipuram	12°49'60N	79°43'00E
8	Perumbakkam	12°50'00N	79°36'00E
9	Kaveripakkam	12°51'00N	79°30'00E
10	Pudhupadi	12°52'00N	79°24'60E
11	Walajapet	12°53'60N	79°21'60E
12	Ranipet	12°55'60N	79°19'60E
13	Vizharam	12°55'00N	79°15'60E
14	Rathnagiri	12°52'60N	79°12'60E
15	Sathuvancheri	12°53'60N	79°09'00E
16	Vellore	12°55'60N	79°07'00E
17	Melmanavur	12°55'00N	79°04'60E
18	Virinjipuram	12°55'00N	79°01'00E
19	Kothikuppam	12°55'00N	78°57'60E
20	Pallikonda	12°55'60N	78°55'60E
21	Madhanoor	12°53'60N	78°52'60E
22	Melpatti	12°51'60N	78°57'00E
23	Vadapudupatti	12°42'00N	78°48'60E
24	Ambur	12°46'00N	78°42'00E
25	Jothiveeraraghavapuram	12°44'60N	78°40'60E
26	Gollakuppam	12°42'00N	78°39'60E
27	Vaniambadi	12°40'00N	78°37'00E
28	Ambalur	12°38'00N	78°35'60E
29	Avarakuppam	12°39'60N	78°34'60E
30	Kanaganachiammankoil	12°37'60N	78°33'60E



Figure 2. 3 Sampling Location of Site number 6 (Valajabath)



Figure 2. 4 Sampling Location of site number 10 (Pudhupadi)



Figure 2.5 Sampling Location of site number 18 (Virinjipuram)

CHAPTER 3

LITERATURE SURVEY

References for the measurement of radioactive hazards in Palar river sediments through grain size and magnetic separation has been taken in order to familiarise the radioactive exposure of natural materials. In order to know the recent work on this field of study, some of the references are reviewed are as follows.

According to Suresh et al (2011), the toxicity and contamination levels of numerous heavy metals have been investigated in detail. Heavy metals are evaluated for their possible risks using conventional toxicological and geological reference values, which are established by the scientific community. When compared to other metals, those that are already present have a greater impact on River ecosystems than those that are not. PLI is a technique for assessing the quantity of heavy metals in sediment that is used in environmental monitoring. Other characteristics, such as the closeness of pollution sources, have a bigger impact on sediment heavy metal content than mineralogy in determining sediment heavy metal content. The composition of heavy metals has a significantly smaller effect on radioactivity than does the mineralogy of the metal.

According to **Suresh et al (2011)**, there has been research done on the toxicity and contamination levels of specific heavy metals in the environment. Heavy metals are studied by experts using traditional toxicological and geological reference values to determine the potential dangers of exposure to heavy metals. Existing metals have a higher impact on River ecosystems than new metals that have recently been identified. PLI can be used to assess the amounts of heavy metals in sediment. The presence or absence of pollution sources is more relevant in determining sediment heavy metal content than the presence or absence of mineralogy. The composition of heavy metals has a significantly less significant impact on radioactivity than does mineralogy.

In this work, **Paramasivam et al (2019)**, discovered that the mineral and magnetic properties of sediment radioactivity levels discovered in the Vaigai River are good markers of sediment radioactivity levels. Confirming the presence of dia, ferri, antiferrari, and ferrihydrate magnetic minerals was accomplished through the use of magnetic susceptibility tests in both horizontal and vertical perspectives, as

well as through the analysis of magnetic susceptibility data from various angles (horizontally and vertically). Radium and magnetic materials are highly absorbable in lattice defects, crystal and grain boundaries, and other lattice defects because of their cation exchange capacity.

The work of **Saravanan et al (2020)**, who concentrated on the DRASTIC technique, which was used to assess groundwater vulnerability in the Upper Palar River basin, which is located in the Indian state of Tamil Nadu. Net recharge parameters for the DRASTIC model were estimated using four different approaches: SCSCN, Piscopo, Chaturvedi and groundwater Fluctuation recharge methods, as well as groundwater Fluctuation recharge methods, as well as groundwater Fluctuation recharge methods. A total of four different recharge estimating methodologies were used to generate the maps, including the water table Fluctuation approach, the Piscopo approach, the SCS-CN approach, and empirical Chaturvedi equations. Results were classified into four categories: low, moderate, high, and extremely high, with the lowest scoring category being the lowest. In accordance with the findings of the DRASTIC study, which employed the Chaturvedi approach, the southern hemisphere appears to be particularly vulnerable, while the northern and western hemispheres appear to be less vulnerable. The lower section of the River and its southeast bank are highly vulnerable to flooding, whereas the northern basin of the River has a modest sensitivity to flooding. When it comes to detecting very high sensitivity declines, groundwater fluctuation is being utilised. The south-west and east regions of the River basin are relatively less vulnerable to floods than the rest of the basin. Because of the numerous ways used in the study to calculate the recharge rate, it was revealed that the vulnerability is based on that logic.

According to the findings of **Inigo Valan et al (2017)**, gamma spectroscopy was used to analyse sediment samples from the Tamiraparani River in Tamil Nadu, India, for the presence of primordial radionuclides. The samples came from the Tamiraparani River in Tamil Nadu, India. According to the findings, these levels are greater than the global median estimates published by the United Nations Scientific and Technological Commission on the Environment and Resources. In the case of River sediments, the radiation values calculated were found to be higher than what was considered safe at the time. The correlation matrix demonstrated a positive

association between a variety of geochemical parameters and the concentrations of primordial radionuclide activity. This relationship is consistent with previous findings. Actinide activity was shown to be connected with the outcomes of heavy metal examinations, which was also discovered. Investigations of solid-state electrical conductivity on heavy mineral samples were carried out in order to discover whether or not there was a relationship between the conductivity and primordial radionuclide activity during the formation of the minerals.

Using a NaI detector, **Murugesan et al (2015)**, determined the activity concentrations of ^{238}U , ^{232}Th , and ^{40}K in sediments from the Palar River in Tamil Nadu, India, with the goal of determining the activity concentrations of these elements in sediments from the River. The criterion formula was used to calculate the absorption rate, radiation equivalent concentration, as well as the exterior and interior harmful indices, among other things. When they got their results, they compared them to the internationally recognized safety levels. Aside from that, the rate of radioactive heat production as well as the excess lifetime cancer risk are calculated. A dose rate monitor, known as an ERDM, has been installed at every site along the River's length. It measures the rate of dose absorption and compares it to the rate that had previously been recorded. The radioactivity values in quartz and feldspar are inversely proportional to the magnetic susceptibility and mineral weight of the minerals, respectively. In order to distinguish between sediments with a low or high radiation danger, the weight of the magnetic minerals can be used as a reference to determine the relative weight of the minerals.

Ndour. O et al (2020) evaluated the activity levels of ^{226}Ra , ^{232}Th , and ^{40}K in twenty cement samples obtained from Senegalese construction material suppliers using a low-background digital gamma-ray spectrometer with a broad energy germanium detector and a low-background germanium detector. Concentrations of ^{226}Ra , ^{232}Th , and ^{40}K activity were found to range between 7.1 and 150.3 Bq kg⁻¹, 3.7–16.1 Bq kg⁻¹, and 48.7–133.9 Bq kg⁻¹, respectively. These materials' radiological hazards were further investigated by calculating the exterior and internal indexes, the indoor gamma dose rate, the annual effective dosage, as well as effective dose rates to various human organs and tissues. Upon examination, it was discovered that all applicable limit values for structural building components fell within the appropriate ranges of the radiation hazard indexes.

Darwish D et al (2015) collected eight granite samples from the Saint Katherine region in the South Sinai region of Egypt, which were gamma ray spectroscopically examined with an HPGe detector to obtain the gamma ray spectra for natural radioactivity from the ^{238}U - and ^{232}Th series, as well as from the element ^{40}K . There are several important components of the subject covered in the data provided in this article, including radon equivalent activities, external and internal danger indices, external level indicators, activity utilization index, exposure rate, and other important aspects of the subject. The results, which have been rounded to the nearest tenth, have been displayed using table graphs.

According to Resmi M et al (2018), the current work is focused on the geochemistry of River sediments from the Palar River in the Southern Peninsular of Malaysia. Although River sediment SiO_2 concentrations are higher than UCC values, the concentrations of Al_2O_3 , K_2 , CaO , Na_2O , Mg_2 , P_2 , P_2 , P_5 , Mn_2 and Fe_3 in River sediments are lower than those found in UCC samples. Based on their geochemical makeup, the sediments are primarily composed of arkose, wacke, and shale. When the Th/U Rb/Sr ratio is calculated, as well as the A-CN-K ternary diagram, it is revealed that the Palar River sediments are further supported by immobile element ratio plots and discriminant diagrams, and a large proportion of the sample data points fall around the plagioclase-smectite line. The bivariate plots of Th/Sc and Zr/Sc can be used to deduce the origins of sedimentary rocks.

Chandrasekaran et al (2014), employed isodose maps to analyse the distribution of natural radioactivity in soils from undisturbed areas in the Yelagiri Hills, Tamil Nadu, India. The soils came from undisturbed areas in the Yelagiri Hills, Tamil Nadu, India. This area showed significant levels of natural radionuclides, activity utilisation index, excess lifetime cancer risk, and internal radiation dangers in soil samples obtained from this area, according to the results of the research. The estimated radiation hazard parameters have been subjected to international comparison and evaluation. Using cluster analysis, principal component analysis, and a Pearson correlation coefficient investigation, radiological parameters were investigated to discover whether or not there were any existing links.

CHAPTER 4

EXPERIMENTAL TECHNIQUE

4.1 INTRODUCTION:

The experimental procedure employed here is done using the Thallium activated Sodium Iodide detector. This instrument uses the principle of scintillation. This experimental technique also includes the sampling process and the procedure which is followed in NaI(Tl) detector.

4.1.1 SAMPLING PROCESS:

The collected samples are blended and dried in an oven at 100 degrees Celsius for 24 hours. After that, the samples are packaged and sealed in an impermeable airtight PVC container with a capacity of 250 mL (9 cm 9 6.5 cm: height 9 diameter). For the measurements, around 450–500 g of samples are employed. A period of approximately 4 weeks is required before measurements to bring the ^{238}U , ^{232}Th , and their decay products into equilibrium with each other and the surrounding environment before measurements can be taken. Before counting the samples, the net weight of the samples is established.

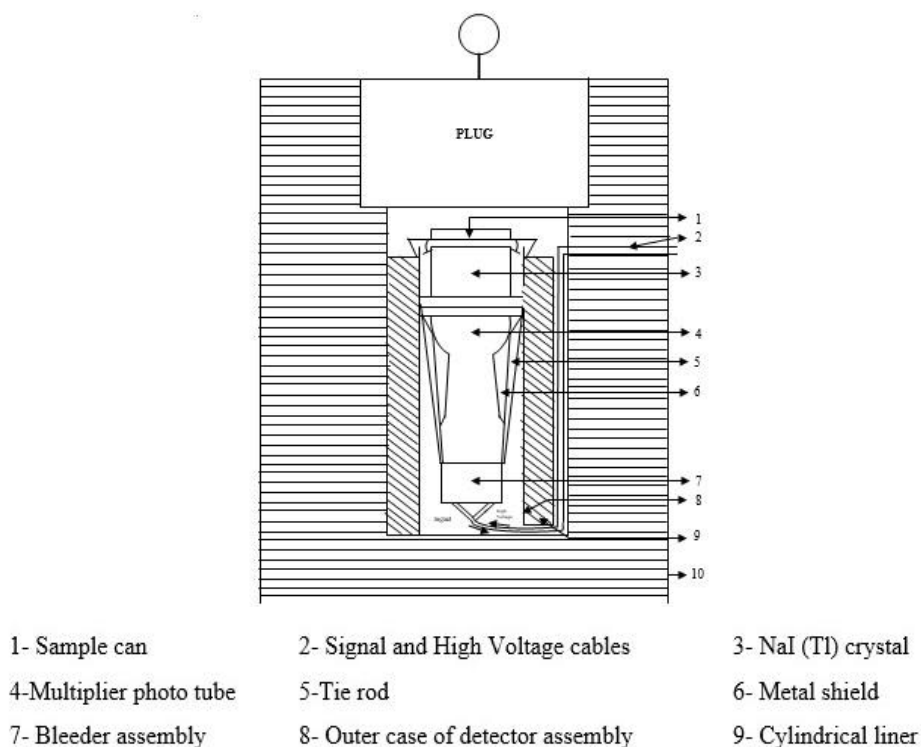


FIG 2.1: Sketch of Gamma Ray Spectrometer

4.1.2 PROCEDURE:

The detection, identification, and measurement of radionuclides in the samples were carried out using a Thallium activated sodium iodide [NaI (TI)] gamma ray spectrometer [NaI (TI)]. In addition to the detector, the system includes an Oxford PCAP multichannel analyser (MCA), which is a PC-based plug-in PCI card consisting of an 80MHz Wilkinson Analogue-to-Digital Converter. The process of gamma ray spectroscopy, which is used to detect radioactive decay. In the photomultiplier tube, gamma rays from a sand sample strike the NaI (TI) crystal, resulting in photons being emitted from the photocathode, which are multiplied by the photomultiplier tube. A preamplifier connected to the detector collects the charges generated by the photomultiplier tube and generates a voltage that is proportionate to the charge applied to the detector (pulses). The voltage pulses are shaped and their sizes are increased by the amplifier. The voltage pulse is digitally represented by the multichannel analyser.

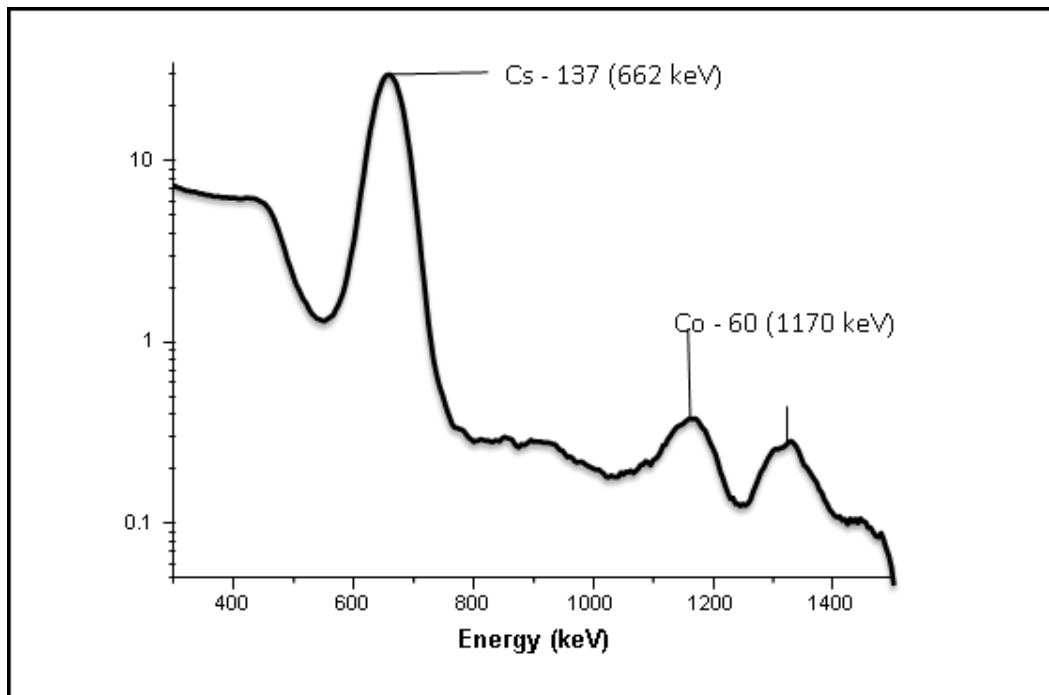


FIG 3.2: Energy Graph

The following is the energy calibration of the NaI (TI) spectrometer: In nuclear energy, energy calibration is the process of correcting a detector's output to be consistent with the standard IAEA radionuclides. This is done in order to obtain the relationship between peak positions and the related nuclear energy. To account for

variations in weather, vibrations, and the heating up of the detector, this was done at the beginning of each measurement. It was accomplished through the measurement of gamma ray emission peaks from sources with precisely known energy and the comparison of the measured peak position with the known energy. Cobalt-60 was utilised to calibrate the photo peak at 662 keV, while cesium-137 and cobalt-60 were used to calibrate the photo peak at 1170 keV and 1330 keV, respectively. The calibration equation of the polynomial fit is given in the form of equation (**Debertin and Helmer, 1988**):

$$E = Y_0 + C_1B + C_2B^2$$

Where E is the photon energy, B is the channel number and (Y₀, C₁ and C₂) are fit parameters.

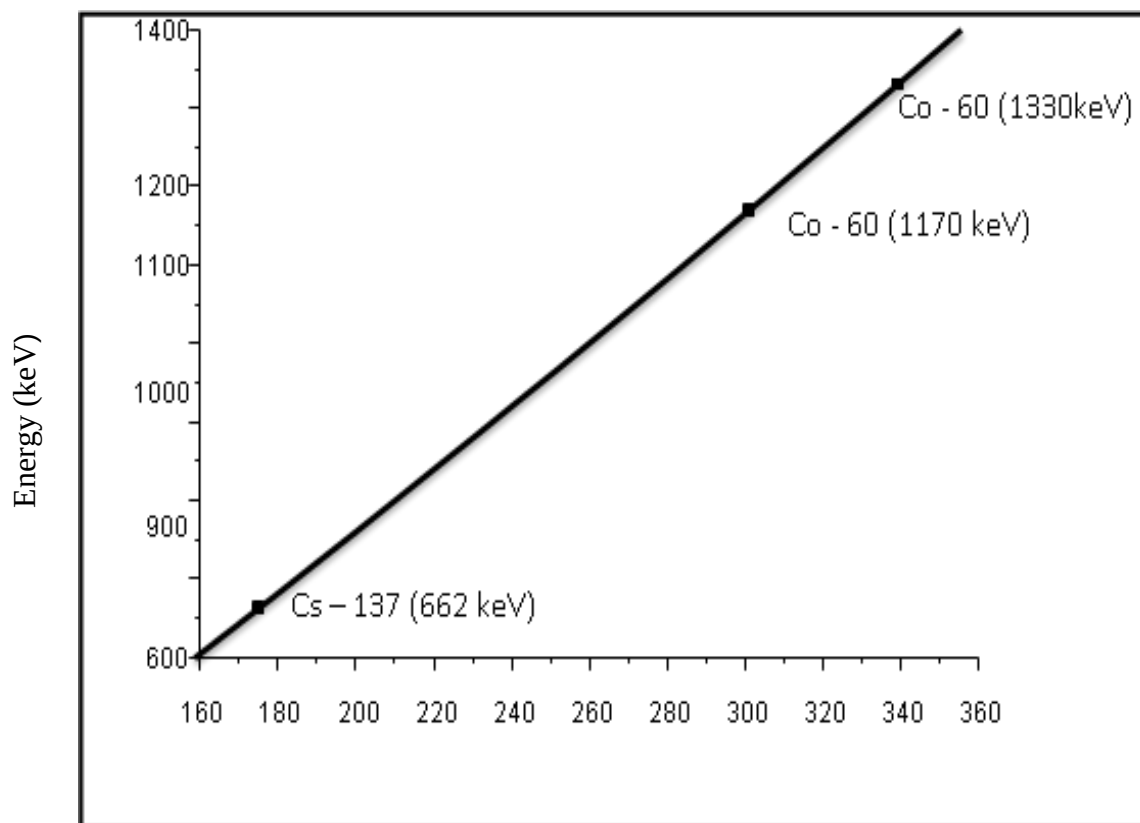


FIG 3.3: Energy calibration graph

For the energy calibration, the fit parameters of the polynomial equation were utilised to fit the connection between photon energy and channel number as a function of channel number.

Table 4. 1 Energy calibration parameter and fitted value

Parameter	Fitted value
Y0	13.9 ± 0.7
C1	3.5 ± 0.2
C2	0.0010 ± 0.0001

4.1.3 Energy resolution of the detector:

This is the ability of a detector to differentiate the photon energies of two or more closely lying radionuclides. The energy resolution of the detector was determined by fitting a Gaussian model to the measured cesium – 137 photo peak. The result of the fitting is shown. The Gaussian model equation used to plot figure is shown in equation:

$$Y = Y_0 + \frac{A}{w\sqrt{\frac{\pi}{2}}} \exp\{-2(x - x_c)w\}^2$$

Y_0 is the baseline offset, A is the area under the curve, x_c is the center of the peak and w is width of the curve at half height.

CHAPTER 5

RESULT AND DISCUSSION

5.1 CRITERIA FORMULA FOR RADIOLOGICAL DOSE AND HAZARDOUS PARAMETERS:

River sand refers to the loose, scattered, and naturally-occurring sand consisting of extremely microscopic particles of decayed shells, corals, or boulders. Sand is not only an essential component of the river, but it also plays a significant role in the building sector as well. Current usage and utilization are widespread and extensive all over the world, where it is used to provide bulk, strength, and other properties to building materials such as concrete and asphalt. It is one of the most commonly used and utilized materials in the construction process and is widely used and utilized all over the world. River sand is often employed in the construction of buildings in Tamil Nadu and neighbouring states. It is not uniform in each river when it comes to the distribution of uranium, thorium, and potassium isotopes in different environmental compartments. The research area does not have appropriate statistical data for cancer, the average lifespan of humans, typical health conditions, or any other issue relevant to the study. Instead than relying on average radioactivity, the maximum radiation should be taken into consideration instead. In order to assess radioactive hazard of river sediments, it is useful to calculate different radioactive indices using the following formulas.

5.1.1 Radiological Dose Parameters:

The calculation and correlation of radiological dose parameters such as indoor (AD_{in}) and outdoor (AD_{out}) absorbed dose, Internal (E_{in}) and External (E_{ex}) Annual Effective Dose Equivalent are used to limit radiation exposure to living things while river sand is used as a building material.

5.1.1.1 Absorbed Dose Rate (AD):

The absorbed dose rate which are tabulated to provide a characteristics of external terrestrial gamma radiation are shown. Absorbed gamma dose rate is the amount of energy from ionizing radiation that is absorbed per unit mass per unit time of matter, in Gray. The absorption dosage is used to calculate the probability of biochemical changes occurring in certain tissues. The addition of natural radionuclides add to the absorbed dose rate (DR) which depends on how much ^{238}U ,

^{232}Th , and ^{40}K are present in the environment. The majority of the gamma radiation comes from radionuclides which are found in earth's surface. The absorbed dose rate (D_{in} nGy h^{-1}) is calculated using the following equation.

$$D_{\text{in}} = (0.92 C_{\text{U}} + 1.1 C_{\text{Th}} + 0.081 C_{\text{K}})$$

$$D_{\text{out}} = (0.427 C_{\text{U}} + 0.662 C_{\text{Th}} + 0.043 C_{\text{K}})$$

Where C_{U} , C_{Th} and C_{K} are the activity concentrations of ^{236}U , ^{232}Th and ^{40}K , respectively.

5.1.1.2 Annual Effective Dose equivalent (AEDE):

In order to identify how much radiation one is exposed to each year, one has to take into account, the conversion coefficient from the absorbed dose in air to how much radiation is absorbed. The possibility of a harmful effect from radiation exposure is dependent on which part(s) of the body is exposed and amount of radiation is exposed. Some organs are more vulnerable to radiation than others, while some are more sensitive than others. This is taken into consideration via the application of a tissue weighting factor (WT). A dose to an organ is calculated by multiplying the equivalent dosage to that organ by the tissue weighting factor for that organ. The result is the effective dose to that organ. The Sievert is the metric unit of effective dosage (Sv). If more than one organ is exposed, the effective dosage, denoted by the letter E, is the total of the effective doses received by all of the organs that were exposed.

Table 5. 1: Annual Effective Dose received by Human Organs

Tissue	Tissue weighting factor W_{T}	Sum of Tissue weighting factors
Bone-marrow (red), colon, lung, stomach, breast, remaining tissues(*)	0.12	0.72
Gonads	0.08	0.08
Bladder, oesophagus, liver, thyroid	0.04	0.16
Bone surface, brain, salivary glands, skin	0.01	0.04
	Total	1.00

The annual effective dose rates (nGy h⁻¹) for indoor and outdoor in units of mSv y⁻¹ were calculated using the following formula:

$$\text{AEDE Outdoor} = ((D_{\text{out}} \times 24 \times 365 \times 0.8 \times 0.7) / 1000000) \text{ mSv y}^{-1}$$

$$\text{AEDE Indoor} = ((D_{\text{in}} \times 24 \times 365 \times 0.8 \times 0.7) / 1000000) \text{ mSv y}^{-1}$$

Where D is the dose rate.

Total Annual Effective Dose (E_{tot}):

The total annual effective dose E_{tot} is given by the following

$$E_{\text{tot}} = E_{\text{in}} + E_{\text{out}}$$

5.1.2 Radiological Hazardous Parameters:

The calculations and correlations of several radiological hazardous indices, such as the Excessive Lifetime Cancer Risk (ELCR), H_{in} and H_{out} indices, the Alpha Index (I_{α}), the Gamma Index (I_{γ}), the Activity Utilization Index (AUI), Radium equivalent, Radioactive heat production (RHP) are analysed.

5.1.2.1 Excessive Lifetime Cancer Risk (ELCR):

Potential carcinogenic effects are quantified by predicting the probability of cancer incidence over a certain lifespan in a population of individuals using estimated intakes (and exposures) and chemical-specific dose–response data (i.e., slope factors). The added or increased risk of acquiring cancer is caused by an individual's lifelong exposure to a harmful substance. The outdoor, indoor and total ELCR were calculated according to the estimated values of the annual effective doses and is given by (Ramasamy et al. 2009):

$$\text{ELCR (outdoor)} = E_{\text{out}} \times DL \times RF$$

$$\text{ELCR (indoor)} = E_{\text{in}} \times DL \times RF$$

$$\text{ELCR}_{\text{tot}} = \text{ELCR}_{\text{out}} + \text{ELCR}_{\text{in}}$$

5.1.2.2 Internal Hazard Index (H_{in}):

Internal hazard index is defined as the radiation that happens when a person consumes anything that releases radiation. The internal hazard index is used to figure out how much radon and its compounds are in one's body (H_{in}). The radiation then enters and radiates directly into the human body, resulting in radiological dangers.

$$H_{in} = (C_U 185 + C_{Th} 259 + C_K 4810) \leq 1$$

5.1.2.3 External Hazard Index (H_{ex}):

The external hazard (H_{ex}) index is another radiation hazard index to measure the indoor radiation dose rate related to the external exposure to gamma radiation from natural radionuclides in building materials. The external hazard index measures the risk caused by natural gamma radiation. This index is used to determine a material's radiological compatibility. This index's primary goal is to keep radiation doses below the permissible dose equivalent limit of 1 mSv⁻¹. In order to limit the radiation hazard to a minimum, H_{ex} must be less than unity. If $H_{ex} < 1$ indicates that materials-related activities are safe and do not result in excessive amounts of radiation exposure.

$$H_{ex} = (C_U 370 + C_{Th} 259 + C_K 4810) \leq 1$$

5.1.2.4 Radium Equivalent Activity (Ra_{equ}):

The Ra_{equ} is a widely used index for describing the gamma output of different combination of uranium, thorium, and potassium in sediments which are collected from various places. Radium equivalent activity yields gamma index gives from the combination of ²²⁶Ra or ²³⁸U ²³²Th and ⁴⁰K in the sample, Where A (1.43), B (0.077) are constants.

$$Ra_{equ} = (C_U + A C_{Th} + B C_K)$$

5.1.2.5 Activity Utilization Index (AUI):

To estimate the air dose rates from various fusions of the above-mentioned fundamental radionuclides in sand and soils. By inserting the appropriate conversion factors, this AUI is calculated.

$$AUI = \left(\frac{C_U}{50 \text{ Bqkg}^{-1}} \right) f_U + \left(\frac{C_{Th}}{50 \text{ Bqkg}^{-1}} \right) f_{Th} + \left(\frac{C_K}{500 \text{ Bqkg}^{-1}} \right) f_K$$

where C_U , C_{Th} , and C_K are the actual values of the activities per unit mass (Bq kg⁻¹) of ²³⁸U, ²³²Th, and ⁴⁰K in the building materials considered; and f_U , f_{Th} , and f_K are the fragmentary contributions due to gamma radiation from the above environmental radioactive nuclides, which are 0.462, 0.604, and 0.041, respectively.

5.1.2.6 Alpha Index and Gamma Index (I_α and I_γ):

In order to check out whether the safety requirements for building materials are being fulfilled, a activity concentration index or external hazard, I_α is used to calculate

alpha index whereas I_γ is calculated as gamma index as proposed by the European Commission.

$$I_\alpha = \frac{C_u}{200 \text{ Bqkg}^{-1}} \leq 1$$

$$I_\gamma = \frac{C_U}{300 \text{ Bqkg}^{-1}} + \frac{C_{Th}}{200 \text{ Bqkg}^{-1}} + \frac{C_K}{3000 \text{ Bqkg}^{-1}} \leq 1$$

5.1.2.7 Radioactive Heat Production (RHP):

The rate of radioactive heat generation determines the lithosphere's thermal evaluation, and the above mentioned environmental radioactive isotopes contributed significantly to this terrestrial heat flow. These fundamental radioactive elements (^{238}U , ^{232}Th , and ^{40}K) become critical in determining the composition of the earth's mantle and crust, as well as their heat-generating capability.

$$A = 10^{-5} \times \rho \times (9.52 C_U + 2.56 C_{Th} + 3.48 C_K)$$

Where A - RHP in μWm^{-3} , ρ - sample density in Kgm^{-3} , C_U and C_{Th} – uranium and thorium concentration in ppm and C_K - potassium concentration in %.

5.2 Results for sediments greater than 125 microns in size and nonmagnetic sediment samples:

5.2.1 Radiological doses and hazardous parameters for sediments greater than 125 microns in size:

Radioactivity concentration of ^{238}U , ^{232}Th and ^{40}K in Palar River Sediment Samples are measured by NaI (TI), gamma ray detector is shown in Table 5.2. The ^{238}U activity ranges from 5.64 to 18.44 Bq kg⁻¹, ^{232}Th activity ranges from 6.13 to 254.06 Bq kg⁻¹, and ^{40}K activity ranges from 483.49 to 883.79 Bq kg⁻¹. In addition to natural processes like weathering and leaching, human activities also contribute in changes. Radionuclide activity is measured differently at each location. These variances are related to local characteristics in different regions, as well as a physical and chemical sorting process which differs from place to place. This could be because of the field's drainage pattern (E.g. Vellore). ^{238}U , ^{232}Th , and ^{40}K have average radioactivity of 4.25, 6.56, and 370.81 Bq kg⁻¹ respectively, with activity concentrations in the following order: The concentration of ^{40}K , ^{232}Th , ^{236}U . ^{236}U , ^{232}Th and ^{40}K are much lower.

From table 5.2 the average concentration of ^{236}U , ^{232}Th and ^{40}K are 4.25, 6.56 and 370.81 Bqkg⁻¹ and they are slightly lower than the world average as well as the Indian mean values (world averages of ^{236}U , ^{232}Th , and ^{40}K are 35, 30 and 400 Bqkg⁻¹ respectively). Average concentration of ^{236}U and ^{232}Th are lower and ^{40}K concentrations higher compared with the Indian mean values (14.8 Bqkg⁻¹, 64 Bqkg⁻¹ and 400 Bqkg⁻¹ for ^{238}U , ^{232}Th and ^{40}K respectively **(Shanthi, G et al)**). The main purpose of radioactivity testing is to figure out how much radiation may be safely given to the general public. The formula which are mentioned above can be used to calculate various radioactivity indices in order to assess the radioactive hazard of River sediments.

Table 5.2: Radioactivity Concentration of ^{238}U , ^{232}Th and ^{40}K

S.No	U Bq kg ⁻¹	Th Bq kg ⁻¹	K Bq kg ⁻¹	S.No	U Bq kg ⁻¹	Th Bq kg ⁻¹	K Bq kg ⁻¹
1	2.23	7.50	280.13	17	5.77	10.65	358.78
2	5.10	7.92	280.43	18	3.38	7.48	291.84
3	8.34	9.76	274.56	19	3.92	5.37	310.45
4	5.78	6.87	289.98	20	1.34	1.64	378.11
5	4.89	5.63	300.89	21	2.74	4.16	336.87
6	3.89	3.73	357.65	22	4.31	8.34	291.32
7	8.80	14.99	745.75	23	2.63	4.38	358.97
8	4.98	5.37	369.23	24	4.89	6.89	320.27
9	3.31	4.10	456.16	25	2.10	5.63	323.98
10	3.27	4.42	476.32	26	3.88	4.67	343.76
11	6.88	8.90	457.54	27	3.45	5.08	345.10
12	4.76	6.51	545.16	28	6.79	5.56	399.78
13	1.83	4.85	437.54	29	5.20	7.49	245.24
14	1.74	3.35	356.75	30	3.45	4.25	346.19
15	4.12	5.92	414.23	Max	8.80	15.31	745.75
16	3.87	15.31	431.21	Min	1.34	1.64	245.24
				Mean	4.25	6.56	370.81

Table 5.3 shows that the maximum absorbed dose rate for $>125\ \mu\text{m}$ grain size for indoor is slightly higher than the world average dose rate of $84\ \text{nGy/h}$. Whereas the calculated values are ($\text{AD}_{\text{in max}} = 84.99\ \text{nGy/h}$) and Outdoor values ($\text{AD}_{\text{out max}} = 45.16\ \text{nGy/h}$) are similarly found to be lower than the world average outdoor dose rate of $59\ \text{nGy/h}$. The site P7 along the river has the absorbed dose rate which is slightly higher when compared to world average and it has high exposure which may cause metabolic changes which occur inside the human body. The calculated values of AD_{in} and AD_{out} values varies from 32.89 to $84.99\ \text{nGy/h}$ and 17.43 to $45.16\ \text{nGy/h}$ with their mean values such as 41.16 and $21.85\ \text{nGy/h}$. The calculated AEDE_{in} values vary 161 to $417\ \mu\text{Svy}^{-1}$, with a mean of $202\ \mu\text{Svy}^{-1}$, which is lower than the world average indoor value of $450\ \mu\text{Svy}^{-1}$. The calculated AEDE outdoor values vary from 21.4 to $55.4\ \mu\text{Svy}^{-1}$, with a mean of $26.8\ \mu\text{Svy}^{-1}$, which is lower than the world average outdoor value of $70\ \mu\text{Svy}^{-1}$.

Table 5.3: Radiological dose parameters for sediments greater than 125 microns in size:

S.No	ADin nGy/h	ADout nGy/h	AEDE(IN) (msv/y)	AEDE(out) (msv/y)	S.No	ADin nGy/h	ADout nGy/h	AEDE(IN) (msv/y)	AEDE(out) (msv/y)
1	32.99	17.67	0.16	0.02	17	46.08	24.53	0.23	0.03
2	36.12	19.17	0.18	0.02	18	34.98	18.65	0.17	0.02
3	40.65	21.45	0.20	0.03	19	34.66	18.37	0.17	0.02
4	36.36	19.22	0.18	0.02	20	33.66	17.85	0.17	0.02
5	35.06	18.53	0.17	0.02	21	34.38	18.25	0.17	0.02
6	36.65	19.36	0.18	0.02	22	36.74	19.56	0.18	0.02
7	84.99	45.16	0.42	0.06	23	36.31	19.29	0.18	0.02
8	40.40	21.35	0.20	0.03	24	38.02	20.15	0.19	0.02
9	44.50	23.58	0.22	0.03	25	34.37	18.34	0.17	0.02
10	46.45	24.63	0.23	0.03	26	36.55	19.35	0.18	0.02
11	53.18	28.16	0.26	0.03	27	36.71	19.48	0.18	0.02
12	55.70	29.53	0.27	0.04	28	44.74	23.55	0.22	0.03
13	42.46	22.62	0.21	0.03	29	32.89	17.43	0.16	0.02
14	34.18	18.17	0.17	0.02	30	35.89	19.01	0.18	0.02
15	43.86	23.26	0.22	0.03	Max	84.99	45.16	0.417	0.0554
16	55.33	29.73	0.27	0.04	Min	32.89	17.43	0.161	0.0214
					Mean	41.16	21.85	0.202	0.0268

From table 5.4 it shows that since the external hazardous index measures the radiological compatibility, the calculated index values varies from 0.09 to 0.24 Bq kg⁻¹, with a mean of 0.11 Bq kg⁻¹, and the calculated internal index measures the presence of radon and its compounds in a human body, whose values varies from 0.09 to 0.26 Bq kg⁻¹, with a mean of 0.13 Bq kg⁻¹. The external and internal hazardous index for site P7 is lower than the world average and this site's sediments are safe for constructional purpose. Here the calculated radium equivalent activity values ranged from 32.77 to 87.66 Bq/kg, with a mean value of 42.18 Bq/kg. When compared to world average the radium equivalent values are less and sediments can be used for construction purpose. Along with these, ELCR outdoor, indoor, and total values range from 0.15 to 0.85, 1.11 to 6.12, and 1.25 to 6.97, respectively, with mean values of 0.15, 1.11, and 1.25. The ELCR_{tot} value for the site P7 is found to higher than the world average and has cancer risk when compared to other sites. The RHP rate ranges from 0.12 to 0.43 μWm^{-3} , with 0.21 μWm^{-3} which is the average. The site P7 has higher value when compared to other sites, but when we actually compare with world average the RHP value is found to be less than 1. The world average values for parameters such as hazardous internal and external values, radium equivalent activity, and ELCR indoor and total values, are found to be $H_{ex} = 0.5 \text{ Bq kg}^{-1}$, $H_{in} = 0.5 \text{ Bq kg}^{-1}$, Radium equivalent activity $Ra_{eq} = 129.7 \text{ Bq/kg}$, $ELCR_{out} = 0.290 \times 10^{-3}$, $ELCR_{tot} = 1.45$ and the radioactive heat rate is $1.00 \mu\text{Wm}^{-3}$.

From table 5.5 the Activity Utilization index values varies from 0.05 to 0.33 with the mean value 0.15. These values indicate that AUI is <2 and these sediments can be used for construction purpose. Along with this alpha and gamma activity concentration index value varies from 0.01 to 0.04 and 0.09 to 0.35 with the average values 0.02 and 0.17 respectively.

Table 5.4: Radiological Hazardous parameters for sediments greater than 125 microns in size:

S.No	Hex Bq kg ⁻¹	Hin Bq kg ⁻¹	Ra _{equ} Bq/Kg	ELCR outdoor x10 ⁻³	ELCR indoor x10 ⁻³	ELCR _{tot} X10 ⁻³	RHP μWm ⁻³	S.No	Hex Bq kg ⁻¹	Hin Bq kg ⁻¹	Ra _{equ} Bq/Kg	ELCR outdoor x10 ⁻³	ELCR indoor x10 ⁻³	ELCR _{tot} X10 ⁻³	RHP μWm ⁻³
1	0.09	0.10	34.53	0.08	0.57	0.64	0.17	17	0.13	0.15	48.63	0.11	0.79	0.90	0.27
2	0.10	0.12	38.02	0.08	0.62	0.70	0.21	18	0.10	0.11	36.55	0.08	0.60	0.68	0.20
3	0.12	0.14	43.44	0.09	0.70	0.79	0.26	19	0.10	0.11	35.50	0.08	0.60	0.67	0.19
4	0.10	0.12	37.93	0.08	0.62	0.71	0.20	20	0.09	0.09	32.79	0.08	0.58	0.65	0.12
5	0.10	0.11	36.11	0.08	0.60	0.68	0.18	21	0.09	0.10	34.63	0.08	0.59	0.67	0.17
6	0.10	0.11	36.76	0.08	0.63	0.71	0.16	22	0.10	0.12	38.67	0.08	0.63	0.71	0.22
7	0.24	0.26	87.66	0.19	1.46	1.65	0.43	23	0.10	0.11	36.53	0.08	0.62	0.71	0.17
8	0.11	0.12	41.09	0.09	0.69	0.79	0.20	24	0.11	0.12	39.40	0.09	0.65	0.74	0.21
9	0.12	0.13	44.30	0.10	0.76	0.87	0.19	25	0.09	0.10	35.10	0.08	0.59	0.67	0.16
10	0.12	0.13	46.27	0.11	0.80	0.90	0.19	26	0.10	0.11	37.03	0.08	0.63	0.71	0.17
11	0.15	0.17	54.84	0.12	0.91	1.03	0.29	27	0.10	0.11	37.28	0.08	0.63	0.71	0.19
12	0.15	0.16	56.05	0.13	0.96	1.08	0.26	28	0.12	0.14	45.52	0.10	0.77	0.87	0.25
13	0.11	0.12	42.46	0.10	0.73	0.83	0.17	29	0.09	0.11	34.79	0.07	0.56	0.64	0.21
14	0.09	0.10	34.00	0.08	0.59	0.66	0.13	30	0.10	0.11	36.18	0.08	0.62	0.70	0.17
15	0.12	0.13	44.48	0.10	0.75	0.85	0.21	Max	0.24	0.26	87.66	0.19	1.46	1.65	0.43
16	0.16	0.17	58.97	0.13	0.95	1.08	0.31	Min	0.09	0.09	32.79	0.07	0.56	0.64	0.12
								Mean	0.11	0.13	42.18	0.09	0.71	0.80	0.21

Table 5.5: Activity Utilization Index, Alpha and Gamma Index for sediments greater than 125 microns in size:

S.No.	AUI	Gamma (I_γ)	Alpha (I_α)	S.No.	AUI	Gamma (I_γ)	Alpha (I_α)
1	0.13	0.14	0.01	17	0.21	0.19	0.03
2	0.17	0.15	0.03	18	0.15	0.15	0.02
3	0.22	0.17	0.04	19	0.13	0.14	0.02
4	0.16	0.15	0.03	20	0.06	0.14	0.01
5	0.14	0.14	0.02	21	0.10	0.14	0.01
6	0.11	0.15	0.02	22	0.16	0.15	0.02
7	0.32	0.35	0.04	23	0.11	0.15	0.01
8	0.14	0.17	0.02	24	0.15	0.16	0.02
9	0.12	0.18	0.02	25	0.11	0.14	0.01
10	0.12	0.19	0.02	26	0.12	0.15	0.02
11	0.21	0.22	0.03	27	0.12	0.15	0.02
12	0.17	0.23	0.02	28	0.16	0.18	0.03
13	0.11	0.18	0.01	29	0.16	0.14	0.03
14	0.09	0.14	0.01	30	0.11	0.15	0.02
15	0.14	0.18	0.02	Max	0.32	0.35	0.04
16	0.26	0.23	0.02	Min	0.06	0.14	0.01
				Mean	0.15	0.17	0.02

5.2.2 Radiological doses and hazardous parameters for nonmagnetic sand samples:

An electromagnet is used to separate the nonmagnetic sediment samples from the magnetic substances present in the sediments. The radiation doses and parameters are then determined using the nonmagnetic sediment samples that have been isolated earlier.

From Table 5.6 the measured activity value ranges from 1.01 to 8.45 Bq kg⁻¹ for ²³⁸U, 4.12 to 32.12 Bq kg⁻¹ for ²³²Th. 103.74 to 230.61 Bq kg⁻¹ for ⁴⁰K. Radioactivity concentration of ²³⁸U, ²³²Th and ⁴⁰K in Palar River Sediment Samples are Measured by (NaI (TI)), the gamma ray detector is shown in Table 5. Measured activity of Radionuclides varies from site to site. These variations arises due to local features by chemical sorting process which differs from place to place. This can also be due to the drainage pattern of field of study. Apart from these natural processes, human Activities are also known to contribute to change. The average radioactivity of ²³⁸U, ²³²Th, ⁴⁰K is 2.03, 10.44 and 167.44 Bq kg⁻¹ are respectively, the activity concentrations are in the following order: The concentration of ⁴⁰K, ²³²Th, ²³⁸U and ²³⁸U Much lower than ²³²Th and ⁴⁰K.

Table 5.6: Radioactivity Concentration of ^{238}U , ^{232}Th and ^{40}K :

S.No.	U Bq kg ⁻¹	Th Bq kg ⁻¹	K Bq kg ⁻¹	S.No.	U Bq kg ⁻¹	Th Bq kg ⁻¹	K Bq kg ⁻¹
1	4.23	8.43	123.11	17	1.52	7.13	175.72
2	1.45	7.21	151.72	18	1.58	6.49	163.15
3	2.81	7.13	165.12	19	1.16	6.32	213.76
4	1.23	4.12	215.88	20	1.08	16.35	208.51
5	1.12	8.94	135.26	21	1.01	22.93	230.61
6	1.62	8.78	130.78	22	1.03	16.47	226.96
7	1.13	10.67	127.57	23	4.66	16.31	214.34
8	2.18	9.73	142.54	24	1.89	13.24	103.74
9	1.32	13.79	151.15	25	1.12	7.21	156.94
10	2.33	8.62	144.26	26	1.12	5.62	177.93
11	3.21	7.42	158.73	27	1.12	7.14	154.11
12	1.47	6.24	156.27	28	2.51	7.31	156.79
13	1.12	12.08	212.14	29	3.09	12.21	125.32
14	2.13	9.23	137.63	30	8.45	32.12	203.71
15	1.06	5.85	181.89	Max	8.45	32.12	230.61
16	1.12	8.12	177.52	Min	1.01	4.12	103.74
				Mean	2.03	10.44	167.44

From Table 5.7, The maximum value of absorbed dose rate for less nonmagnetic grain size for indoor is calculated to be less than world indoor average dose rate of 87 nGy/h (calculated value ($AD_{in\ max}$ is 59.61 nGy/h) and outdoor values ($AD_{out\ max} = 32.38$ nGy/h) are also found to be less than or equal to world outdoor average dose rate of 59nGy/h, whereas the AD in and out values varies from 20.87 to 59.60 nGy/h and 11.23 to 32.37 nGy/h with their mean values such as 26.91 and 14.57 nGy/h. The sites have less absorbed dose rate for indoor and outdoor, and it will be less exposed to gamma radiation as well as metabolic changes which occurs inside the human body. The calculated $AEDE_{in}$ values are ranged from 102.40 to 292.406 μSvy^{-1} with a mean value of 132.02 μSvy^{-1} , which is lesser than the world average indoor value of 450 μSvy^{-1} . Outdoor calculated values are ranged from 13.77 to 39.70 μSvy^{-1} with a mean value of 17.86 μSvy^{-1} , which is lesser than the world average outdoor value of 70 μSvy^{-1} .

Since the hazardous external index measures the radiological compatibility, from table 5.8, calculated values varies from 0.04 to 0.19 Bq kg^{-1} with the mean value of 0.08 Bq kg^{-1} and for internal index measures the presence of Radon and its compounds in human body, whose calculated values are found to be 0.04 to 0.22 Bq kg^{-1} with the mean value of 0.09 Bq kg^{-1} . Both external and internal indices are lower than the world average and sites are said to be safe for construction purposes. The radium equivalent activity calculated values varies from 22.43 to 70.07 Bq/kg with the mean value of 29.85 Bq/kg. Here the ELCR outdoor, indoor value and total varies from 0.05 to 0.14, 0.36 to 1.02 and 0.41 to 0.52 with their mean values 0.06, 0.46 and 0.52 respectively. The radioactive heat production rate varies from 0.32 to 0.49 μWm^{-3} with the average value of radioactive heat production rate is 0.37 μWm^{-3} and is also found to be lower than world average. These above mentioned values of $ELCR_{tot}$ values are found to be greater than the world average for all the sites which will be having high risk when compared to other sites. The average world values for parameters such as hazardous internal and external values, radium equivalent activity along with the ELCR indoor and outdoor values are found to be $H_{ex} = 0.5 \text{ Bq kg}^{-1}$, $H_{in} = 0.5 \text{ Bq kg}^{-1}$, Radium equivalent activity $Ra_{eq} = 129.7 \text{ Bq/kg}$, the $ELCR_{out} = 0.290 \times 10^{-3}$, $ELCR_{tot} = 1.45 \times 10^{-3}$ and the radioactive heat rate is 1.00 μWm^{-3} .

Table 5.7: Radiological dose parameters for nonmagnetic sediment samples:

S.No.	ADin nGy/h	ADout nGy/h	AEDE(IN) (msv/y)	(OUT)AEDE (msv/y)	S.No	ADin nGy/h	ADout nGy/h	AEDE(IN) (msv/y)	AEDE(out) (msv/y)
1	23.14	12.35	0.11	0.02	17	23.47	12.65	0.12	0.02
2	21.55	11.63	0.11	0.01	18	21.81	11.73	0.11	0.01
3	23.80	12.74	0.12	0.02	19	25.33	13.62	0.12	0.02
4	23.15	12.37	0.11	0.02	20	35.87	19.61	0.18	0.02
5	21.82	11.86	0.11	0.01	21	44.83	24.63	0.22	0.03
6	21.74	11.79	0.11	0.01	22	37.45	20.46	0.18	0.03
7	23.11	12.62	0.11	0.02	23	39.59	21.37	0.19	0.03
8	24.25	13.12	0.12	0.02	24	24.71	13.52	0.12	0.02
9	28.63	15.65	0.14	0.02	25	21.67	11.72	0.11	0.01
10	23.31	12.57	0.11	0.02	26	21.62	11.63	0.11	0.01
11	23.97	12.82	0.12	0.02	27	21.37	11.55	0.10	0.01
12	20.87	11.23	0.10	0.01	28	23.05	12.37	0.11	0.02
13	31.50	17.13	0.15	0.02	29	26.42	14.32	0.13	0.02
14	23.26	12.58	0.11	0.02	30	59.61	32.38	0.29	0.04
15	22.14	11.92	0.11	0.01	Max	59.61	32.38	0.29	0.04
16	24.34	13.17	0.12	0.02	Min	20.87	11.23	0.10	0.01
					Mean	26.91	14.57	0.13	0.02

Table 5.8: Radiological hazardous parameters for nonmagnetic samples:

S.No	Hex Bq kg ⁻¹	Hin Bq kg ⁻¹	Ra _{equ} Bq/Kg	ELCR outdoor x10 ⁻³	ELCR indoor x10 ⁻³	ELCR tot X10 ⁻³	RHP μWm ⁻³	S.No	Hex Bq kg ⁻¹	Hin Bq kg ⁻¹	Ra _{equ} Bq/Kg	ELCR outdoor x10 ⁻³	ELCR indoor x10 ⁻³	ELCR _{tot} X10 ⁻³	RHP μWm ⁻³
1	0.07	0.08	25.76	0.05	0.40	0.45	0.18	17	0.07	0.07	25.25	0.05	0.40	0.46	0.39
2	0.06	0.07	23.44	0.05	0.37	0.42	0.13	18	0.06	0.07	23.42	0.05	0.37	0.42	0.41
3	0.07	0.08	25.72	0.05	0.41	0.46	0.14	19	0.07	0.08	26.66	0.06	0.43	0.49	0.41
4	0.06	0.07	23.74	0.05	0.40	0.45	0.10	20	0.11	0.11	40.52	0.08	0.62	0.70	0.42
5	0.07	0.07	24.32	0.05	0.37	0.43	0.14	21	0.14	0.14	51.56	0.11	0.77	0.88	0.46
6	0.07	0.07	24.25	0.05	0.37	0.42	0.36	22	0.11	0.12	42.06	0.09	0.64	0.73	0.42
7	0.07	0.07	26.21	0.05	0.40	0.45	0.36	23	0.12	0.13	44.49	0.09	0.68	0.77	0.46
8	0.07	0.08	27.07	0.06	0.42	0.47	0.38	24	0.08	0.08	28.81	0.06	0.42	0.48	0.40
9	0.09	0.09	32.68	0.07	0.49	0.56	0.39	25	0.06	0.07	23.51	0.05	0.37	0.42	0.40
10	0.07	0.08	25.76	0.05	0.40	0.45	0.40	26	0.06	0.06	22.86	0.05	0.37	0.42	0.35
11	0.07	0.08	26.04	0.06	0.41	0.47	0.42	27	0.06	0.07	23.20	0.05	0.37	0.42	0.46
12	0.06	0.06	22.43	0.05	0.36	0.41	0.43	28	0.07	0.07	25.04	0.05	0.40	0.45	0.43
13	0.09	0.10	34.73	0.07	0.54	0.61	0.39	29	0.08	0.09	30.20	0.06	0.45	0.52	0.44
14	0.07	0.08	25.93	0.05	0.40	0.45	0.39	30	0.19	0.21	70.07	0.14	1.02	1.16	0.49
15	0.06	0.07	23.43	0.05	0.38	0.43	0.38	Max	0.19	0.22	72.14	0.14	1.02	1.16	0.49
16	0.07	0.07	26.40	0.06	0.42	0.47	0.37	Min	0.04	0.04	14.89	0.05	0.36	0.41	0.32
								Mean	0.08	0.09	29.85	0.06	0.46	0.52	0.37

Table 5.9: Activity Utilization Index, Alpha and Gamma Index for nonmagnetic sediment samples:

S.No.	AUI	Gamma (I_γ)	Alpha (I_α)	S.No.	AUI	Gamma (I_γ)	Alpha (I_α)
1	0.151	0.097	0.021	17	0.115	0.099	0.008
2	0.113	0.091	0.007	18	0.106	0.092	0.008
3	0.126	0.100	0.014	19	0.105	0.107	0.006
4	0.079	0.097	0.006	20	0.225	0.155	0.005
5	0.129	0.094	0.006	21	0.305	0.195	0.005
6	0.132	0.093	0.008	22	0.227	0.161	0.005
7	0.150	0.100	0.006	23	0.258	0.169	0.023
8	0.149	0.103	0.011	24	0.186	0.107	0.009
9	0.191	0.124	0.007	25	0.110	0.092	0.006
10	0.137	0.099	0.012	26	0.093	0.091	0.006
11	0.132	0.101	0.016	27	0.109	0.091	0.006
12	0.102	0.088	0.007	28	0.124	0.097	0.013
13	0.174	0.135	0.006	29	0.186	0.113	0.015
14	0.142	0.099	0.011	30	0.483	0.257	0.042
15	0.095	0.093	0.005	Max	0.483	0.257	0.042
16	0.123	0.104	0.006	Min	0.079	0.088	0.005
				Mean	0.159	0.115	0.010

From table 5.9 the Activity Utilization index values vary from 0.079 to 0.483 with the mean value 0.159. This number indicates that AUI is <2 and this sediments can be used in construction materials. Along with this alpha and gamma activity concentration index value varies from 0.088 to 0.257 and 0.005 to 0.042 with the average values 0.115 and 0.010.

CHAPTER 6

CONCLUSION

Systematic investigations are carried out on sand samples with a size greater than 125 microns in order to understand the distribution of natural radionuclide concentrations. AEDE (indoor and outdoor), ELCR, and RHP values from prior investigations are carried out on bulk samples are clearly superior to those obtained from the current study, as seen above. This study's findings demonstrate that by eliminating particles with grain size less than 125 micron, the exposure rate to radiation is exponentially reduced, confirming the lower risk of developing cancer. This study mean R_{equ} , H_{ex} , and H_{in} values are all lower than the suggested international limits. The mean value of the activity concentration index and the rate of RHP production are both below the internationally suggested limit as is the RHP rate. This has resulted in less impact factor when it comes to radioactive hazard while the sediments of the Palar River are employed as building material. All other sites, with the exception of P7, are less than the world average, which slightly has the high risk of cancer i.e. the radiation exposure. The results of the non-magnetic sand samples demonstrate that when non-magnetic components are eliminated from the sand samples, the radiation impact is reduced as a consequence. Annual effective dosage equivalent and ELCR data provide confirmation of this claim. With the exception of site P30, all other sites are less than the world average, allowing this location to be avoided for building development in the future. In greater than 125 μm size sediment samples the systematic studies are carried out to understand the distribution of natural radionuclide concentration. It clearly shows excellent results compared with AEDE (indoor and outdoor), ELCR, and RHP values of previous studies carried out for bulk samples. From the observed results, it shows that when removing lesser than 125- μm size particles from the sand the exposure rate of the radiation is exponentially decreased and it confirms the lesser risk rate of cancer. Except the site P7, all other sites are lesser than the world average which has the high risk of cancer, so this site can be avoided for building construction. In this study, the mean value of R_{equ} , H_{ex} , and H_{in} was lower than the recommended international limit respectively. The mean value of the activity concentration index and RHP rate is also below the international recommended limit. As a result, the sediments of the Palar River pose a lesser impact factor as a radioactive hazard

when used as a construction material. The result of non-magnetic sand samples also shows reduced radiation impact when non-magnetic materials were removed from the sand samples. It is confirmed through the results of the annual effective dose equivalent and ELCR. When we compare the values of nonmagnetic sand samples, they are found to be lower than the world average and are safe for constructional purposes. But in sand samples which are greater than 125 microns in size the site P7, has the higher risk of cancer rate and it cannot be used for building construction. Whereas all other sites except P7 are lesser than the world average and can be used for building construction.

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