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# Soil pollution assessment in salt field area of Kelambakkam, Tamilnadu using different analytical techniques

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ABSTRACT

The aim of this study is to assess the soil pollution status in the salt field area of Kelambakkam, Tamilnadu using different analytical techniques. The natural radioactivity and pH, electrical conductivity (EC) and soil texture (sand, silt, clay) are determined using gamma ray spectrometer and standard methods respectively. The pH of The pH of soil ranged from 7.2 to 8.00 indicating that the soils are alkaline in nature. The radiation gamma dose rate value in the study area is found to be lower than world average value given by UNSCEAR, 1988. The results of the present work are compared with earlier work from different parts of the countries in the World. The multivariate statistical techniques such as correlation, factor and cluster analysis were employed between radioactive and Physico-chemical variables to identify the soil pollution sources. The statistical analysis indicated that percentage of the sand and slit can alter the concentration of radionuclides. This study may be basic line work for future investigations.



## 1. Introduction

Human activity such as mining, smelting, industry, agriculture and burning fossil fuels pollutes our soil. The disposal materials such as paint, electronic waste, and sewage also contributes to the burden of contamination in soil. The increasing industrial activities can cause soil pollution which is a widespread problem in the world. Organic chemicals are also part of our industrial legacy, and many are still widely used today. Complex mixtures of these chemicals in the environment and in our bodies pose major challenges to toxicologists trying to understand the health impacts of these widespread substances.

Soil is polluted by natural and anthropogenic activities. Soil pollution causes undesirable change in the physical, chemical and biological properties of soil, which affects human life, plants and animals, industrial progress, living conditions and cultural assets. This undesirable change also affects the soil texture (% sand, % silt and % clay), pH, electrical conductivity, bulk density, porosity density and color of the soil. Anthropogenic activities such as indiscriminate use of fertilizers and pesticides, disposal of industrial and domestic effluents, municipal sewage sludge and solid waste, cause undesirable changes in the physical, chemical and biological parameters of the soil. However, the soil also acts as physical, chemical and biological filter to minimize this pollution [1]. Many research groups are actively engaged in soil pollution using physical and chemical properties for pollution status in soil [2–5].

The radioactive materials or contaminates arise from wastes from mining uranium and thorium plants and wastes from hospitals, medical and other research laboratories. These can be deposited on the earth's surface. Radiations through plant intake may reach animals, man and create health problems. Few regions in the world like China, Iran, Brazil and India, etc. were known as natural high radioactive pollution areas due to natural radionuclides where very high terrestrial radiation dose values were reported. Therefore, the measurements of natural radionuclides in soil are of a great interest for many researchers throughout the world, which led to worldwide national surveys in the last two decades [6–8].

Soil radioactive pollution is due to presence of radioactive materials or elements in soil that emit radiation, thus they are not stable and get transformed into other radioactive or non-radioactive materials. Many radioactive elements (materials) are naturally present in the environment. Most of them are used in nuclear power plants, and as basic components of nuclear weapons. Examples of this type of materials are Caesium-137, Strontium-90, Plutonium-238, Uranium-235. Other examples of radioactive elements with include: Cesium-137 (used to treat cancers), Chromium-51 (used in studies of red blood cell survival), Cobalt-57 and Cobalt-60 (used in nuclear medicine), Calcium-47 (used in biomedical research), Iodine-123 (used to diagnose thyroid diseases), Krypton-85 (indicator lights), Nickel-63 (used in explosives detection), Radium-226 (lightning rods), Strontium-85 (used in the study of bone formation), Thorium-229 (fluorescent lights), Tritium (used in drug metabolism studies), Uranium-234 (used in dental fixtures like crowns). Many researchers determined the concentration of radionuclides in soils [9–10].

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The present study aims to assess the soil pollution through the (i) analysis of physic-chemical properties in soils of Kelambakkam salt field area (ii) determination of concentration of natural radionuclides using NaI(Tl) detector (iii) determination of radiological parameters (iv) finding the relation between natural radionuclides and physico-chemical properties of soil.

## 2. Materials and methods

### 2.1. Sample collection and preparation

Soil samples were collected at different locations of salt field area of Kelambakkam, Tamilnadu. The samples were collected at a depth of 5–10 cm. At the collection points, after removing the top cover, plants and stones, about 2 kg of soil samples were collected and packed in pre-cleaned airtight plastic bags, labeled and transported to the laboratory, pulverized and made to pass through a 2-mm mesh sieve. The samples were air-dried stored in pre-cleaned plastic containers for determination of pH and electrical conductivity.

In order to determine the concentration of radionuclides, 500–600 g soil samples were dried in an oven at 105 °C for 24 h to obtain the constant dry weight and then were transferred into airtight PVC containers of uniform size (height: 12 cm, diameter: 6 cm) to its total height to avoid distribution of the gamma radiation-emitting decay products. The samples were sealed assuming that $^{222}$Rn and $^{220}$Rn do not escape after packing and kept for 28 days to allow radon and its short-lived progenies to reach radioactive equilibrium before measurement using a gamma-spectrometry system [11].

### 2.2. Soil texture measurements

The soil texture (sand, silt, clay) was determined by hand feel method. A small amount of soil sample was taken in hand and enough water added to make a ball. This ball was moved between thumb and forefinger to determine the feel characteristics of sand, slit and clay. The feel characteristics for sand, slit and clay were gritty, smooth and sticky respectively. The soil ball was pushed between thumb and forefinger to make a ribbon. The longer the ribbon, the more is the clay content in the soil. The ruler was used to measure the length of the ribbon and the data were recorded. The ribbon classification of soil is given in Table 1. Fig. 1 shows the soil textural [12] triangle which is used to identify the soil texture class.

### 2.3. Soil pH measurements

The pH meter was calibrated using pH 7 buffer solution. Then the meter was adjusted with known pH of buffer solutions 4.0 and 9.2. 20 g of soil was weighed and transferred into 100 ml beaker. 40 ml distilled water was added and stirred well with a glass rod. This was allowed to stand for half an hour with intermittent stirring. The electrode was immersed in soil water suspension and the pH value was determined from the automatic display of the pH meter [13].

**Table 1**
The standard ribbon classification and texture class of soil.

| Ribbon length (cm) | Texture class |
|---|---|
| 0–1.5 | Sand |
| 1.5–2.5 | Sandy loam |
| 2.5–4.0 | Loam |
| 4.0–7.5 | Clay loam |
| >7.5 | Clay |

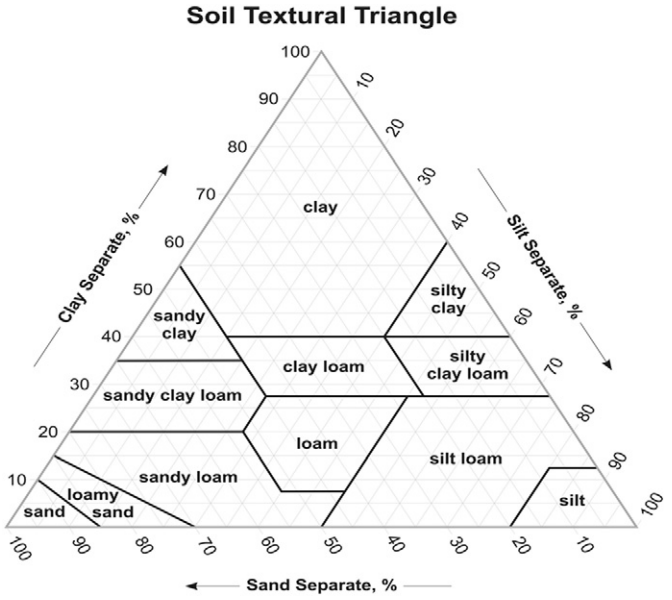


**Fig. 1.** Shows the soil textural triangle.

### 2.4. Soil electrical conductivity (EC) measurements

Electrical conductivity of soil was measured with the help of Electrical Conductivity Meter. The Conductivity Meter was calibrated and cell constant was determined with a Standard Solution of 0.7456 g of dry potassium chloride of 1 l of distilled water. A 20 g of soil sample was shaken with 40 ml of distilled water in a 250 ml conical flask for 1 h. The conductivity of the suppernatent liquid was determined with the help of conductivity meter [4,13].

### 2.5. Radionuclides measurements

All collected samples were subjected to gamma spectral analysis using a 7.62 cm × 7.62 cm NaI(Tl) detector. The energy resolution of the NaI(Tl) detector measured in terms of the full width at half maximum (FWHM) is 50 KeV at the energy of 662 KeV gamma of $^{137}$Cs at 25 cm from the top of the detector. The detector is shielded with 15 cm thick lead on all sides including the top, to reduce the back ground contribution from the surroundings. The inner sides of the lead shielding are lined with 2 mm thick cadmium and 1 mm thick copper to attenuate lead X-rays and cadmium X-rays, respectively. The certified IAEA reference materials RGU, RGTh and RGK were used for the energy and efficiency calibration of the system in the energy range from 186.21 to 2614.53 KeV. The activity contents of the IAEA reference materials, which are housed in 250 ml bottles, are known with 3% of accuracy. The efficiency percentages for $^{40}$K (1.461 MeV), $^{214}$Bi (1.764 MeV) and $^{208}$Tl (2.615 MeV) were found to be 0.154, 0.357 and 0.301cps Bq$^{-1}$, respectively.

The samples were sealed in radon-impermeable plastic containers. The samples were then stored for >30 days to bring $^{222}$Rn and its short-lived daughter products into equilibrium with $^{226}$Ra. The samples were then counted in the same source-to-detector geometry used for the establishment of the efficiency calibration. The spectra were acquired for 20,000 s and the photo peaks were evaluated by the MCA software. The gamma-ray photo peaks corresponding to 1.461 MeV ($^{40}$ K), 1.764 MeV ($^{214}$Bi) and 2.615 MeV ($^{208}$Tl) were considered to determine the activities of $^{40}$K, $^{226}$Ra and $^{232}$Th in the samples. The detection limits of the NaI(Tl) detector system at the 95% confidence level for $^{40}$K, $^{226}$Ra and $^{232}$Th are 8.50, 2.21 and 2.11 Bq kg$^{-1}$ respectively, for a counting time of 20,000 s [14].