Journal of Environmental Radioactivity 130 (2014) 63–67

Contents lists available at ScienceDirect

Journal of Environmental Radioactivity

journal homepage: www.elsevier.com/locate/jenvrad

Uptake of some radionuclides by woody plants growing in the rainforest of Western Ghats in India

P.K. Manigandan [a,*], B. Chandar Shekar [b]

[a] Sai Nath University, Ranchi, India
[b] Kongunadu Arts and Science College (Bharathiar University), Coimbatore, India

ARTICLE INFO

Article history:
Received 26 June 2008
Received in revised form
3 December 2013
Accepted 31 December 2013
Available online 23 January 2014

Keywords:
Western Ghats
Concentration ratio
Bioindicator

ABSTRACT

Transfer of the naturally occurring radionuclides ^{238}U, ^{232}Th, and ^{40}K, and the fallout radionuclide ^{210}Po to different wild plant species in the rainforest of Western Ghats was analyzed. A number of physiologically different plants from the top storey and understorey, such as shrubs and epiphytes, were compared. The concentrations of these radionuclides in the plants and soil were measured using a gamma ray spectrometer and an alpha counter, and were found to vary widely within plants and between species. The soil-plant ratios also varied between species while *Elaeocarpus oblongus* and epiphytic plants exhibited preferential uptake of these radionuclides. As a result, the dust particles trapped in the root systems of epiphytes could be used as bioindicators of fallout radionuclides in the Western Ghats.

1. Introduction

The Nilgiri hill station, part of the Western Ghats of India, is known to have significant monazite deposits (Mishra, 1993; Sunta et al., 2000). The radiation exposure to the population can be estimated from the environmental concentration of radionuclides. The most common pathways for these radionuclides to reach humans involve direct ingestion or inhalation of contaminated dust; however these radionuclides can also be transmitted through the food chain, and these doses are additive. Where dust ingestion or inhalation is minimized as a result of humidity or continuous soil cover, the food chain contribution becomes the primary source. The behavior of these radionuclides is a major determinant of plant uptake. Irrespective of biological necessity, plants have been observed to take up many cations present near their roots, and naturally occurring radionuclides are no exception. Each radioactive element in the soil follows complex dynamics in which part of it goes into the soil solution, while another gradually becomes strongly bound to soil particles. The portion in the soil solution can be incorporated into the plant through the roots. In selected cases, like ^{238}U and ^{232}Th, this is enabled by their chemical similarity with other elements that the plant normally uses for growth. It is important to study their dynamics in the soil and their transfer into plants, as these are basic links in the transport into the food chain. To quantify the transfer of a radionuclide from soil to plant, one generally uses the corresponding transfer coefficient, which is the ratio of the activity concentration in each compartment.

In the food chain model in which the soil/plant relationship is portrayed, plants can be noticed as a hydraulic channel for the water stored in the soil to travel upward and vaporize from the leaves. This movement of water carries radionuclides dissolved in the soil water to the roots. The movement of water is dependent on the retention of soil moisture and supply and is also linked to the size and growth rate of the plant. This process is further complicated by the effects of weather, growth conditions and multiple soil properties. Efforts to model all these processes in automatous manner have not evolved to a broadly applicable level (Baldwin et al., 1973; Barber et al., 1984). Thus, root uptake is often treated at an experimental level, such as with the CR (concentration ratio) model.

Among the radionuclides of interest, the fallout radionuclide ^{210}Po is closely linked with atmospheric moisture and dust particles. The epiphytic plants are contingent on atmospheric moisture and dust particles for their nutrients, resulting in a possible higher absorption and accumulation of atmospheric ^{210}Po. The prominent tree species of the region such as *Elaeocarpus oblongus* and *Michelia nilagirica* (top storey), *Vaccinium nilgherrense* and *Viburnum hebanthum* (understorey), *Lasianthus coffeoiaes* and *Hedyotis stylosa* (shrubs), and *Cymbidium aloifolium* (an orchid) were selected for analysis. Data on the naturally occurring radionuclide concentration in the plants of the Western Ghats region have not been

* Corresponding author.
E-mail addresses: pkmgs@yahoo.com (P.K. Manigandan), chandarshekarbellan@gmail.com (B. Chandar Shekar).

0265-931X/$ – see front matter © 2014 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.jenvrad.2013.12.023

reported previously, and the present study is the first systematic effort to obtain these data. Even though the species selected for the present study are not directly involved in the human food chain, data on the concentration of radionuclides and their transfer factor is important because these data is useful in predicting the soil to plant transfer of the radionuclides.

2. Materials and methods

2.1. Study area

The Nilgiris are a well-defined massif that forms the southern limit of the main Western Ghats system that stretches unbroken from Mumbai in the north to the Nilgiris in the south of India (Fig. 1). The altitude of this region varies from 1700 to 2400 m above mean sea level. This ecosystem is one of the oldest and most important in the Indian peninsula. The annual average rainfall is 1590 mm. The annual temperature variation ranges from approximately 4–24 °C. The total duration of the rainy season is approximately 5 months, from June–October. The soil in the study area is predominantly lateritic, dark brown, and loamy textured with fine medium grains.

2.2. Sample collection

Various species of plants were selected to study the transfer of these radionuclides to the plant from the forest soil. Different samples, such as leaves and bark, were collected from these plants at various locations within the forests of Nilgiris. Soil samples were also collected (20 cm depth) from four different places under the host trees and mixed thoroughly; approximately 2 kg of composite sample was collected in a polythene bag. Similarly, *E. oblongus*, *M. nilagirica*, *V. nilgherrense*, *V. hebanthum*, *L. coffeoiaes*, and *H. stylosa* tree leaves samples of 2 kg each were collected, and soil

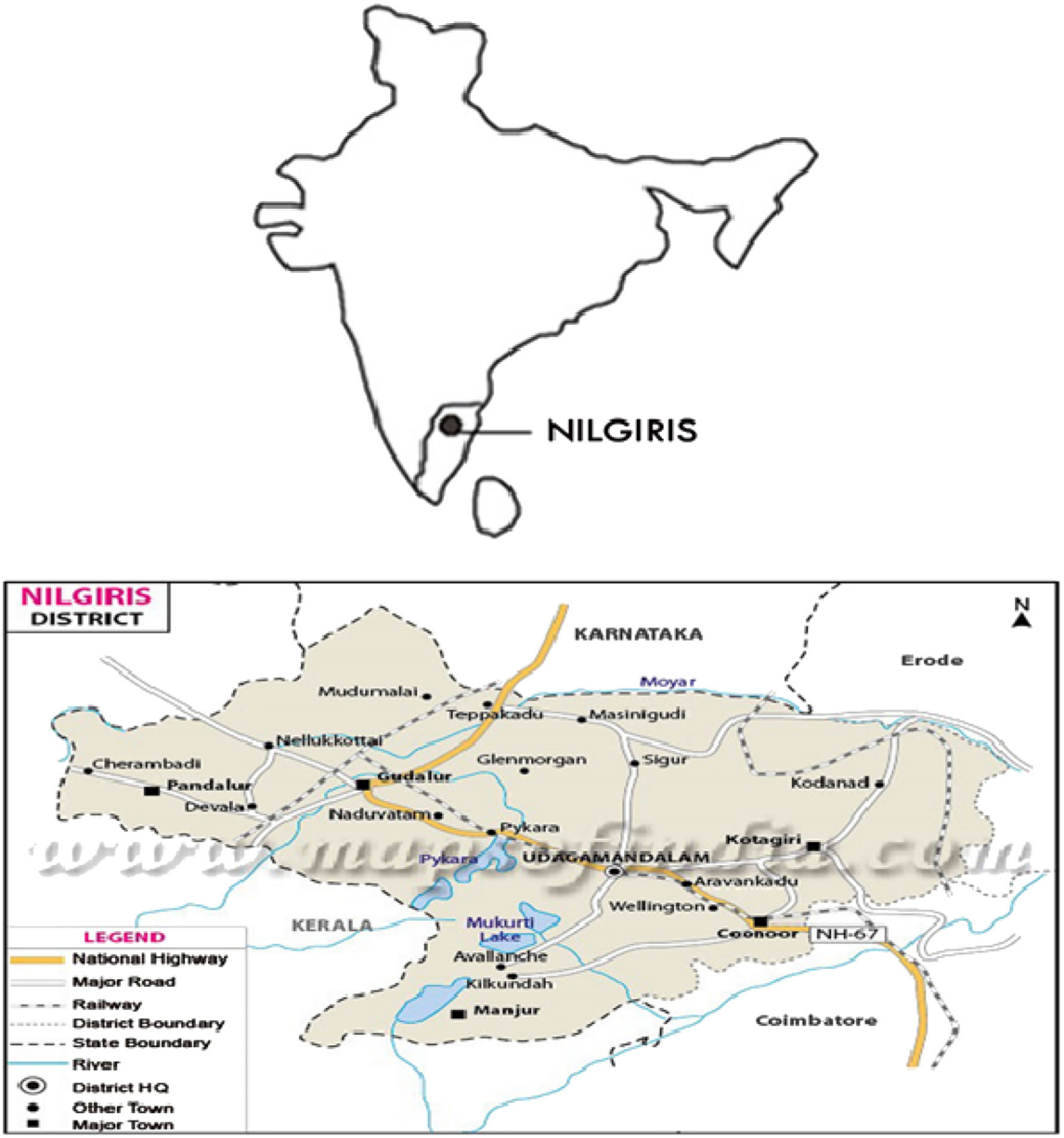

Fig. 1. Study area: Nilgiris district.