



Contents lists available at ScienceDirect

# Construction and Building Materials

journal homepage: [www.elsevier.com/locate/conbuildmat](http://www.elsevier.com/locate/conbuildmat)

## Special Issue

### Use of NORM-containing products in construction

## Radiological aspects for use of woodchip ashes in building industry

Massimo Garavaglia <sup>a,\*</sup>, Silvia Bucci <sup>b</sup>, Elena Caldognetto <sup>c</sup>, Giuseppe Candolini <sup>a</sup>,  
Massimo Faure Ragani <sup>d</sup>, Concettina Giovani <sup>a</sup>, Mauro Magnoni <sup>e</sup>, Cristina Nuccetelli <sup>f</sup>,  
Ilaria Peroni <sup>b</sup>, Rosella Rusconi <sup>g</sup>, Flavio Trotti <sup>c</sup>, Luca Verdi <sup>h</sup>

<sup>a</sup> ARPA FVG, S.O.S Centro Regionale Radioprotezione, via Colugna 42, 33100 Udine, Italy

<sup>b</sup> ARPAT, Unità Operativa Radioattività e Amianto, via Ponte alle Mosse 211, 50144 Firenze, Italy

<sup>c</sup> ARPA Veneto, Osservatorio Agenti Fisici, via A. Dominutti 8, 37135 Verona, Italy

<sup>d</sup> ARPA Valle d'Aosta Loc. Grande Charrière 44, 11020 Saint Christophe (AO), Italy

<sup>e</sup> ARPA Piemonte, Dipartimento Radiazioni, Via Jervis, 30-10015 Ivrea (TO), Italy

<sup>f</sup> ISS (National Institute of Health), National Center for Radiation Protection and Computational Physics, Viale Regina Elena, 299, 00161 Rome, Italy

<sup>g</sup> ARPA Lombardia, Centro Regionale Radioprotezione, via Juvara 22, 20129 Milano, Italy

<sup>h</sup> APPA Alto Adige, Laboratorio di Chimica Fisica, Via Amba Alagi 5, 39100 Bolzano, Italy



### H I G H L I G H T S

- The woodchips produces ashes in which the <sup>137</sup>Cs activity concentration is highly enriched with respect to that of the raw material.
- The use of concrete containing highly contaminated ashes being considered as relevant from the radioprotection point of view.
- A new formulation of the activity concentration index *I* is proposed for a safe and radioprotection sound use of building material containing woodchip ashes.

### A R T I C L E I N F O

#### Article history:

Received 5 July 2017

Received in revised form 22 May 2018

Accepted 22 May 2018

#### Keywords:

Concrete

Woodchips fly ash

Caesium-137

Effective dose

### A B S T R A C T

The use of woodchips of local origin for heating purposes is a diffused practice in some areas, like northern Italian alpine and sub-alpine zones, where large woods and forests extensions occur. In recent years, many thermal plants producing energy using woodchips as fuel have been constructed, supplying single edifices and delivering heated water to small communities through district heating.

Unfortunately, due to the Chernobyl fall-out, particularly relevant in many mountain areas of northern Italy, woodchips of local origin are often contaminated with relevant <sup>137</sup>Cs traces: therefore, the woodchips burning aimed at water heating produces ashes in which the <sup>137</sup>Cs activity concentration is highly enriched with respect to that of the raw material. Typical activity concentrations of <sup>137</sup>Cs in such ashes span a range from a few hundreds to several thousands Bq/kg.

These combustion ashes are subject to different fates, according to reuse opportunities and law restrictions (not referred to the radiological aspects). Landfill disposal is the most common general option, together with the use in compost production plants and concrete factories.

In this paper, we focused in particular to the use of concrete containing highly contaminated ashes, being considered as the most relevant from the radioprotection point of view. Therefore, some evaluations of the public exposure to radiations coming from concrete utilized as building material and containing woodchip ashes with high radioactivity levels (specifically <sup>137</sup>Cs and <sup>40</sup>K) have been done. The dose estimates for a person living in a house built with “contaminated” concrete were made using both standardized gamma radiation exposure indices and simulation models. The results are presented and discussed. Finally, a new formulation of the activity concentration index *I* is proposed for a safe and radioprotection sound use of building material containing woodchip ashes.

© 2018 Published by Elsevier Ltd.

\* Corresponding author.

E-mail address: [massimo.garavaglia@arpa.fvg](mailto:massimo.garavaglia@arpa.fvg) (M. Garavaglia).

## 1. Introduction

The fallout of  $^{137}\text{Cs}$  following the accident at the Chernobyl nuclear power plant was remarkable not only in Eastern Europe but also in many mountain areas of Northern Italy: the intense precipitation phenomena that occurred at that time washed out efficiently the radioactive cloud that entered to Italy the 30th April 1986 and collected to the ground a great quantity of radioactivity ([1–4]). As a result, quite high deposition values were reached in many areas, sometimes approaching and in some cases overcoming the considerable amount of  $100,000 \text{ Bq/m}^2$ . Friuli Venezia Giulia (administrative district in North East Italy) was one of the Italian most affected areas. High concentrations of  $^{137}\text{Cs}$  can still be found nowadays in undisturbed forest soils of the region (see  $^{137}\text{Cs}$  deposition map in Fig. 1) among which those of the Tarvisio forest are probably the most contaminated. This is the area of provenance of the woodchips used as fuel by an energy-producing plant whose ashes were found highly contaminated with  $^{137}\text{Cs}$  during a routine radioactivity control.

The detection of very high activity concentration levels in some ashes samples (up to  $5000 \text{ Bq/kg}$ ) coming from that plant raised concern among the population and local authorities. Many other energy production plants using woodchips of local origin are in fact in operation in Friuli Venezia Giulia and in other northern Italian alpine and sub-alpine areas as well. Therefore, the awareness that the diffusion of these kind of plants might pose radioprotection problems that need to be addressed, pushed the regulation bodies to investigate the issue.

In particular, the Friuli Venezia Giulia Environmental Protection Agency has been asked to assess the radioprotection impact of the possible destination of the ashes produced in this kind of plants. The possible destinations of the ashes are: landfill, reuse as fertilizer or in concrete production [5]. The latter seemed to most relevant from the radioprotection point of view, potentially exposing people to a continuous gamma irradiation from building materials. Therefore, in order to estimate the doses due to employment of

woodchip ashes in building industry, the radioactivity concentration measurements in several biomass ash samples collected in different Italian Alpine region have been carried out. For the sake of comparison, woodchips radioactivity measurements have also been made. The results of the  $^{137}\text{Cs}$  activity concentrations in woodchips are not discussed in detail in this work, since this study was mainly focused on the use of the contaminated ashes; however, as a general comment on this aspect, it can be observed that the ratio between the caesium activity concentration in ash and in wood is highly variable, ranging from a minimum of 9 to a maximum value of more than 800, strongly depending on the heater mode of operation.

Dose estimation based on the ashes measured data are then made, considering as a reference scenario that of a person living in a house made of concrete containing radioactive woodchip ashes. A new formula for the activity concentration index  $I$  is finally given as a useful tool for a safe use of ashes containing  $^{137}\text{Cs}$  in building materials.

## 2. Materials and methods

Woodchips ash samples have been collected from several plants in Friuli Venezia Giulia (North East Italy), Provincia Autonoma di Bolzano (North East Italy) and Valle d'Aosta (North West Italy) and Tuscany (Center Italy). An overall 211 samples were taken, coming from the water heating plants in those Regions. The ash samples have been gathered both from boiler (bottom ash) and from filter (fly ash).

After collection, the ashes have been weighted, packed in polyethylene cylindrical containers and measured as they are by means of gamma spectrometry with hyperpure germanium detectors (about 30% relative efficiency) [6].

Estimates of public exposure to radiation concrete used as building material and containing woodchip ashes were performed according to Radiation Protection 112 methods [7]. The values of

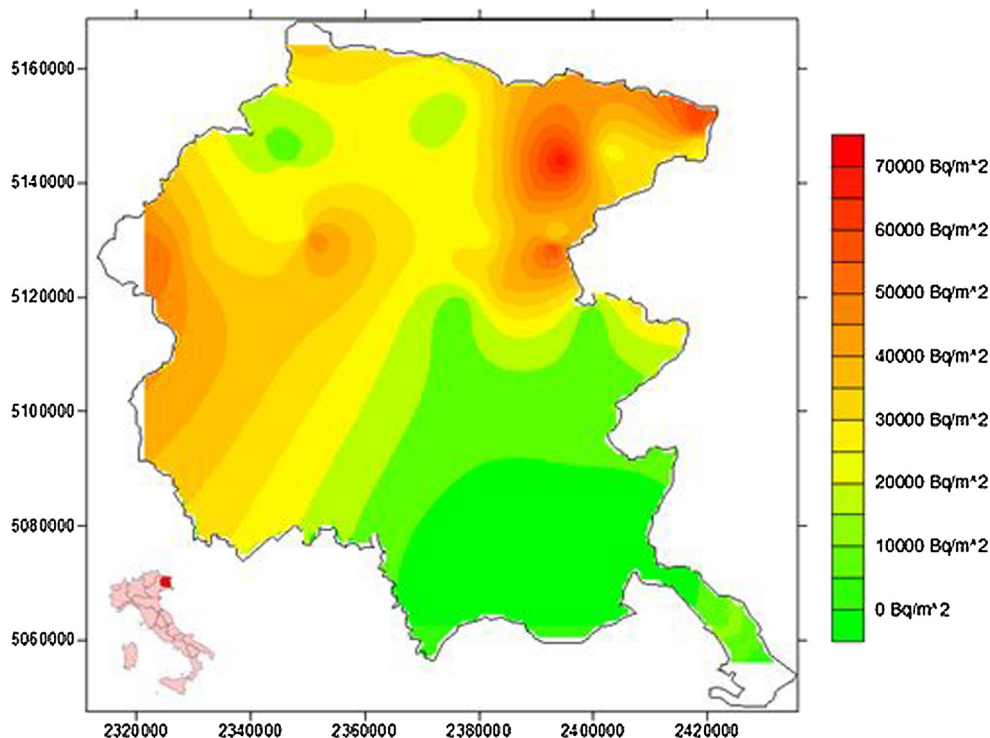


Fig. 1. Deposition map of  $^{137}\text{Cs}$  in the soils of Friuli Venezia Giulia, (North East Italy), 1987.

Download English Version:

<https://daneshyari.com/en/article/6711960>

Download Persian Version:

<https://daneshyari.com/article/6711960>

[Daneshyari.com](https://daneshyari.com)