RADIOENVIRONMENTAL SURVEY OF THE MEGALOPOLIS POWER PLANTS FLY ASH DEPOSITS

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1. Introduction

The Megalopolis lignite field basin is located in the centre of the Peloponnese peninsula in southern Greece. Two lignite-fired Power Plants are in operation in this region: AHSM-A (600MW – 3 units) since the early 70's and AHSM-B (300MW – 1 unit) since the early 90's. An extensive research project for the determination of the natural radioactivity of lignite and ashes from the Megalopolis Power Plants started in the Nuclear Engineering Section of the National Technical University of Athens (NES-NTUA) in 1983. The 6-year project has evolved to an integrated radioenvironmental survey of the Megalopolis lignite field basin area, the results of which are being progressively published. The present work aims at the presentation of a systematic radio-environmental survey of the fly ash deposits within a 5 km radius from the Power Plants. Results regarding (a) γ-dose rate, (b) radon concentration in the ambient air, (c) soil radon exhalation rate and (d) soil gas radon concentration are reported from systematic field measurements at fly ash deposits. In addition, soil sampling has been conducted at the deposits to allow for the determination of the activity of natural radionuclides. The radiological characterization of the fly ash deposits obtained through these results is compared to the natural radioactivity background in the wider Megalopolis area, using results of previous surveys on undisturbed natural soils [1].

2. Materials and Methods

The Power Plants produce over 2 million metric tons of fly ash annually; this is primarily disposed off in deposits located mainly at exhausted lignite mines. These deposits are formed by several meters thick ash layers, covered by a layer of soil. The whole deposition process is a part of the exhausted lignite mines restoration project. Measurements were carried out at three deposit sites “A”, “B” and “C” as presented in Fig.1. Site “A” is a deposit under development, site “B” – created in the 90’s – is a deposit used for livestock cultivation and site “C” – created in the 80’s – is now a well-organized walnut tree plantation. Measurements were also carried out at sites “D”, “E” and “F”. Sites “D” and “E” are located upon the borders between the deposit soil and natural undisturbed soil. Site “F” is located in a potential strip lignite mine; mining at this site has not commenced yet.

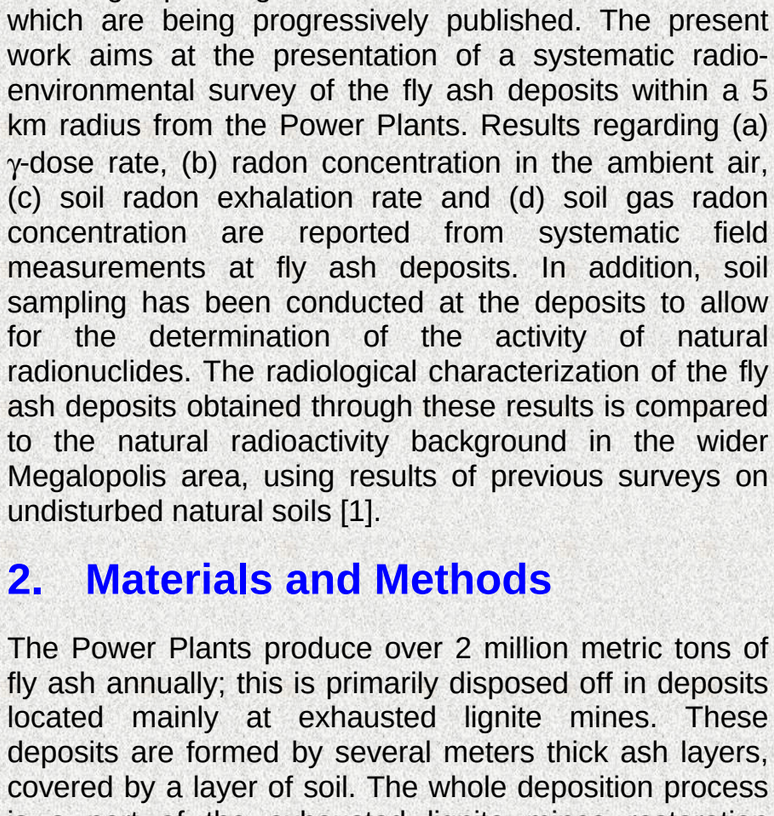

Fig. 1 Megalopolis lignite field basin

All sites “A” to “F” are located within a 5 km radius from the Power Plants. In-situ γ-dose rate at the investigated sites was measured 1 m above the ground using a portable NaI dose rate meter. Radon concentration in the ambient air was measured using various types of active instrumentation. Surface soil radon exhalation rate measurements and soil gas radon concentration measurements were conducted using appropriate instrumentation. Samples from the 0-80 cm soil layer were analysed for natural radioactivity, in the Laboratory, using high-resolution gamma spectroscopy.

3. Results and discussion

Table 1 summarizes the γ-dose rate results and the surface soil natural radioactivity at the surveyed sites. The site referred to as “Area range” represents values measured in undisturbed soils within a 5 km radius from the Power Plants [1]. The γ-dose rate is elevated at site “A” – as expected in a deposit under development – reaching a local maximum of about 500 $nSvh^{-1}$. However, the situation at sites “B”, “C”, “D” and “E” is better and indeed similar to that of the neighbouring area, as reported in [1]. The undisturbed site “F” presents an in-situ rate close to that of site “A”. This may be attributed to large quantities of natural radioactive lignite lying very close to the surface soil.

Table 1: γ-dose rate at surveyed sites ($nSvh^{-1}$) and surface soil natural radioactivity ($Bqkg^{-1}$)

Site	Dose rate	^{226}Ra	^{232}Th	^{40}K
A	500	593	34	326
B	300	320	44	524
C	150	114	32	420
D	250	*80**	*32**	*300**
E	180	*80**	*32**	*300**
F	450	372	37	249
Area range [1]	60-330	26-372	24-41	154-477

(*) estimated from chartographic representations

The gamma spectroscopic analysis shows that the surface soil at sites “B” and “C” has a ^{226}Ra content ranging from 110 to 320 $Bqkg^{-1}$, which is well in agreement with the surface soil survey results reported in [1]. According to the measurements reported in [2] the disposed fly ash has a ^{226}Ra content, which sometimes exceeds 1 $kBqkg^{-1}$. This, in combination with the results of Table 1 leads to the conclusion that all deposits (sites “B” and “C”) are well covered with soil. There is no point for such discussion for site “A”, where deposition works are currently in progress and the fly ash layer is not yet covered by soil.

Fig. 2 Megalopolis-A Power Plant (AHSM-A), as viewed from site “B”

The natural radionuclides content of the 0-80 cm soil layer was also studied. Although it is expected that the fly ash layer underneath the surface should dominate the natural radioactivity vertical profile characteristics, the ^{226}Ra content at 60 - 80 cm depth does not reach the anticipated 1 $kBqkg^{-1}$. It ranges from 80 to 450 $Bqkg^{-1}$, which leads to the conclusion that the surface soil layer is adequately thick and well mixed with the top layer of the disposed fly ash. Cultivation watering and agriculture might have contributed to the mixing.

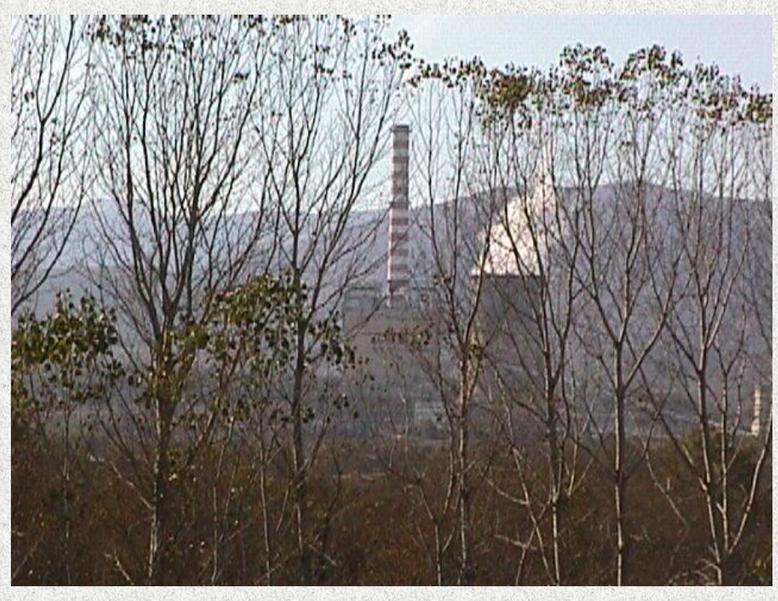

Fig. 3 Megalopolis-B Power Plant (AHSM-B), as viewed from site “B”.

Table 2 summarizes the radon related survey results. No result at any deposit site (“A” to “E”) seems to exceed the area range values measured in the framework of study [1]. The same conclusion is drawn for the potential strip lignite mine site “F”.

Table 2: Radon survey results

Site	Radon in air (Bqm^{-3})	Radon in soil gas ($kBqm^{-3}$)	Radon exhalation rate ($Bqm^{-2}s^{-1}$)
A	20	16	0.010
B	40	39	0.030
C	30-80	42	0.070
D	90	70-250	0.110
E	20	87	0.080
F	50	500	0.210
Area range [1]	ND - 850	4 - 500	ND - 2

ND≡Not Detectable

4. Conclusion

It is concluded that, from the natural radioactivity point of view, the exhausted lignite mines at Megalopolis, in the way that they are restored by fly ash deposition, they do not significantly differ from the rest of the Megalopolis lignite field basin, despite the fact that most of the underground soil layers consist of fly ash with high ^{226}Ra content. A possible explanation for this might be that radon emanation power from the fly ash layer is as low as radon emanation power from natural soil due to fly ash crystallization process in the Power Plant furnace. This explanation is currently under experimental investigation in our Laboratory. Furthermore, the comparison of results from different aged deposition fields concludes that aging and restoration processes in the deposition fields, such as tree cultivation and agriculture, have a positive effect to reducing radon related radiological parameters.

References

1 P.K.Rouni, N.P.Petropoulos, M.J. Anagnostakis, E.P. Hinis and S.E.Simopoulos, "Radioenvironmental survey of the Megalopolis lignite field basin", The Science of the Total Environment, 272(2001); 261-272.

2 S.E.Simopoulos and M.G. Angelopoulos, “Natural Radioactivity Releases from Lignite Power Plants in Greece”, Journal of Environmental Radioactivity 5(1987); 379-389.