Estimation of the 137Cs deposited in Aegean Cretian and Ionian Seas after the Chernobyl Accident

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Greece is one of the European countries significantly affected by the Chernobyl accident., The average value of ^{137}Cs deposition in the mainland part is estimated to be approximately 6 kBq m^{-2}, the regional averages vary between <1.3 and 30 kBq m^{-2}, while local maxima up to 60 kBq m^{-2} have been observed (KRITIDIS and PAPANICOLAOU, 1987). Most of the data for the caesium deposition (over 400) come from gamma-spectrometry of soil samples collected by a standard procedure from all the regions of the country.

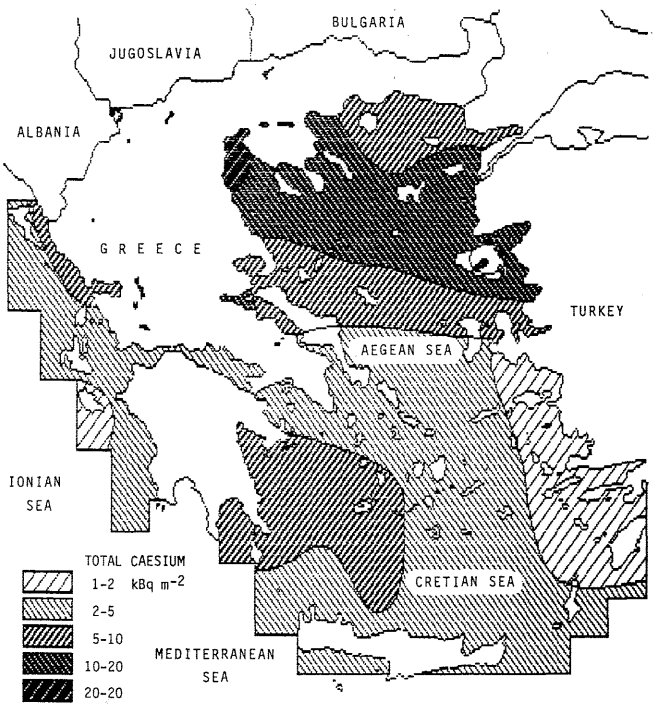

Fig.1. Estimated deposition pattern for total caesium and borders of the sea areas of integration. Note that ^{137}Cs activity equals 66% of the total caesium activity.

A large part of the Greek territory is located close (<50 km) to the sea. The Aegean Sea is surrounded by or includes 23 regions for which the caesium deposition has been estimated. 10 of them belong to islands and 13 to the mainland part of the country. The Ionian Sea includes 4 island regions and borders with 7 mainland regions of the West Greece coast. This allows making a rough estimation of the amounts of ^{137}Cs deposited in the Aegean Sea and in certain parts of the Ionian Sea by interpolating the deposition values for sea regions located between the island and/or mainland "points" and integrating the interpolated values over certain sea areas.

The reliability of such a procedure could be criticized taking into account the irregularities observed in the deposition pattern of the mainland part. To have an idea of the possible deviations of the estimated values from the real ones, we used the data from the coastal and border regions to interpolate for the *inner* parts of the country and to compare the results with the known values for these parts. This led, for two regions of Central Greece, to an underestimation of the regional average by 2-2.5 times. It is clear that the interpolated "sea deposition pattern" provides only a very rough idea of the real situation.

The interpolated data from the above "test" were used also to calculate the average value of the ^{137}Cs deposition in the inland part (38 regions) and to compare it with the average based on the known values. In this case the underestimate was only 12% due to the fact that the interpolation procedure had to be applied in only 8 of the 38 regions. This indicates that the *average* deposition values as well as the total ^{137}Cs input estimated for the Aegean and Ionian Sea could differ from the real value by no more than e.g. ±50%.

The interpolated caesium deposition patterns for the Aegean and Ionian Seas are shown in Fig.1. The average deposition of ^{137}Cs in the Aegean Sea (including Cretian Sea as shown in Fig.1) is estimated to be 4 kBq m^{-2} and the total caesium input in this area of 205,000 km^2 is roughly 8.2×10^{14} Bq. The respective values for the part of the Ionian Sea shown in Fig.1 (area of 24,300 km^2 including the Korinthiakos gulf) are 2.5 kBq m^{-2} and 6×10^{13} Bq. Therefore about 9×10^{14} Bq (24 kCi) of ^{137}Cs has been deposited in a 230,000 km^2 marine area surrounding Greece. If one accepts the estimations presented in DOE (1987), this corresponds to 2.4% of the ^{137}Cs activity deposited in Western Europe and to 0.8% of the total ^{137}Cs released from the damaged Chernobyl reactor.

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The Radioactivity Levels in Rapana Thomasiana thomasiana from the Bosphorus and Black Sea after the Tchernobyl Accident

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Some papers have been published on the occurrence of Tchernobyl radionuclides in the marine environment of the Black Sea (Topcuoglu et al., 1988a; Guven et al., 1990). Radioactivity measurements in some bioindicator marine organisms, particularly those living beneath the sediments were made in order to correlate radionuclides concentration in the organisms with those in the sediments.

The shellfish Rapana thomasiana thomasiana (Gross) was collected from the Bosphorus and Black Sea during the period 1986-1988. The wet weight was determined for all samples. Prior to radioactivity analysis, the soft parts of the animals were dissected. All samples were pooled, freeze-dried for several days to a constant weight and counted.

Table 1. Radioactivity levels in the soft parts of R.thomasiana thomasiana (Bq g^{-1} dry weight). To convert these units to wet weight divide by 4.

Coll. date	Location	^{134}Cs	^{137}Cs	^{106}Ru	^{110m}Ag	Tot.β
1986						
July	Fatsa	0.009±0.005	0.029±0.003	0.143±0.030	0.005±0.004	0.160
Dec.	Sinop	ND	0.002±0.001	0.019±0.008	0.003±0.002	0.168
Dec.	Fatsa	0.007±0.003	0.027±0.004	0.126±0.043	0.007±0.006	0.157
Dec.	Bosp.	ND	0.005±0.003	ND	ND	0.147
1987						
Feb.	Fatsa	0.006±0.004	0.029±0.015	0.065±0.023	0.013±0.010	0.165
June	Fatsa	0.003±0.002	0.009±0.005	0.041±0.012	0.004±0.003	0.185
June	Bosp.	ND	0.003±0.002	ND	0.003±0.002	0.171
July	Sinop	ND	ND	0.015±0.009	0.005±0.004	0.190
Aug.	Bosp.	ND	ND	ND	ND	0.185
1988						
Feb.	Fatsa	ND	0.007±0.006	ND	ND	0.178
Mar.	Sinop	ND	ND	ND	0.002±0.001	0.163
Mar.	Bosp.	ND	ND	ND	ND	0.167

All samples were counted in February and January 1988.

ND: Not Determined

^{134}Cs activity was detected only in Fatsa samples during 1986 and 1987. ^{134}Cs activity was also detected in Black Sea algae during 1987 (Guven et al., 1990). ^{137}Cs activity in July 1986 was 0.029 Bq g^{-1} in the Fatsa sample, decreasing slightly at the same site in June 1987. At the same time, the ^{137}Cs activity was found at very low levels in both Sinop and Bosphorus samples in 1986. It should be noted that the ^{134}Cs and ^{137}Cs activities were found to be higher in Fatsa samples than at other locations. These results were also in good agreement with our prior work (Topcuoglu et al., 1988b). The deposition of the Tchernobyl radionuclides in hazelnut product was found to be higher in the eastern Black Sea region than in the western Black Sea.

The ^{106}Ru activity in the Fatsa sample in July 1986 was 0.143 Bq g^{-1} and decreased to 0.065 Bq g^{-1} level in February 1987 at the same location. ^{106}Ru was also detected in Sinop samples during 1986 and 1987.

After the Tchernobyl accident, ^{110m}Ag was also measured in marine organisms. In the present work, we also detected ^{110m}Ag activity at low levels, in all samples collected during 1986 and 1987 except in those from the Bosphorus.

^{90}Sr activity was below 1×10^{-4} Bq g^{-1} in all samples.

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