^{137}Cs DISTRIBUTION IN THE NORTHERN ADRIATIC SEA (2006-2011)

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INTRODUCTION

The northern Adriatic is a specific Mediterranean environment due to its peculiar climatic and oceanographic characteristics [1]. The dominant sources of anthropogenic radionuclides in the Adriatic Sea are primarily global fallout from the Chernobyl accident in 1986 and indirectly from the Po river discharge [2]. ^{137}Cs is considered to be the most important radionuclide delivered by the fallout used for the assessment of marine pollution by artificial radionuclides [3, 4]. The objectives of this study were a radioecological assessment of the northern Adriatic by the analysis of ^{137}Cs concentrations measured in seawater, sediments, marine organisms and determination of the bioindicator species. A comparison of radioactive contamination was made between different parts of the marine ecosystem including the area of the Po river delta, the protected area of Lim bay and the Rovinj coastal area in the period from 2006 to 2011.

MATERIALS AND METHODS

Samples were collected from 3 locations in the northern Adriatic Sea within the Croatian national program from 2006 to 2011 (Figs 1 and 2). On the station 108, samples of seawater and sediment were collected seasonally. In April and October samples of seawater and *Mytilus galloprovincialis* were collected in Lim bay and samples of seawater, sediments and *Fucus virsoides* were collected in Rovinj coastal area. Fishes *Sardina pilchardus*, *Mugil cephalus* and *Mullus barbatus* were collected from local fishermen and used for analyses.

The methodology used for the sampling, radiochemical analyses and measurements of ^{137}Cs in seawater, sediments and organisms is based on the IAEA TRS No. 118 [5]. The efficiency calibration was carried out using sources provided by the IAEA and Analytics. The samples were counted 80 000 seconds on an HPGe detector system (FWHM 1.82 keV at 1.33 MeV, 25 % relative efficiency) connected with 8192 channel analyzer. Canberra Genie 2000 software was used for the analyses of the spectra recorded.

RESULTS

In area of the Po river delta ^{137}Cs concentrations in seawater were decreased back to pre-Chernobyl values (2.48 Bq m^{-3}), although in sediment they were slightly higher (8.70 Bq kg^{-1}) (Fig. 3). Inside Lim bay area ^{137}Cs concentrations in surface water were low (1.93 Bq m^{-3}) and in mussel *Mytilus galloprovincialis* even undetectable in this period. In the Rovinj coastal area ^{137}Cs concentrations in surface water were remained constant (2.23 Bq m^{-3}), as well as in the surface sediment (1.88 Bq kg^{-1}). ^{137}Cs concentrations were detectable at very low activity levels in *Mugil cephalus* and *Sardina pilchardus* (<0.3 Bq kg^{-1}w.w.). The data indicate that some species like the intertidal brown algae *Fucus virsoides* and benthic fish *Mullus barbatus* are better bioaccumulators of ^{137}Cs than others (Fig. 4).

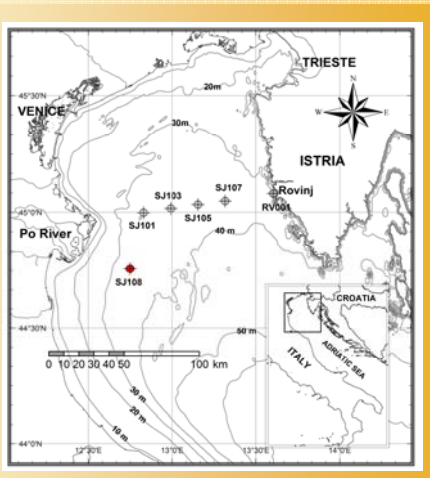

FIG. 1. Station 108 in front of the Po river delta in the northern Adriatic Sea.

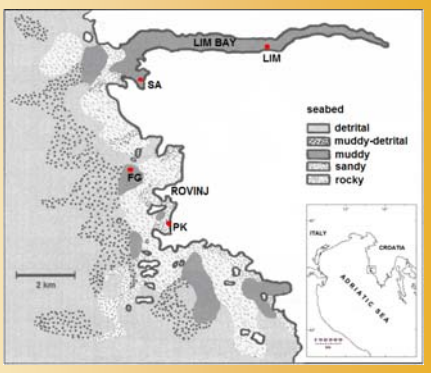

FIG. 2. Sampling locations in Rovinj coastal area. Stations: FG- island Figarola, LIM- Lim bay, PK- Punta Corrente and SA- lagoon Saline.

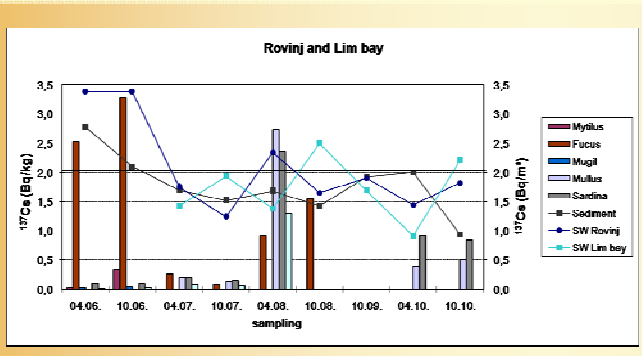

FIG. 4. ^{137}Cs concentrations in seawater, sediments and biota samples in Lim bay and Rovinj coastal area from 2006 to 2011.

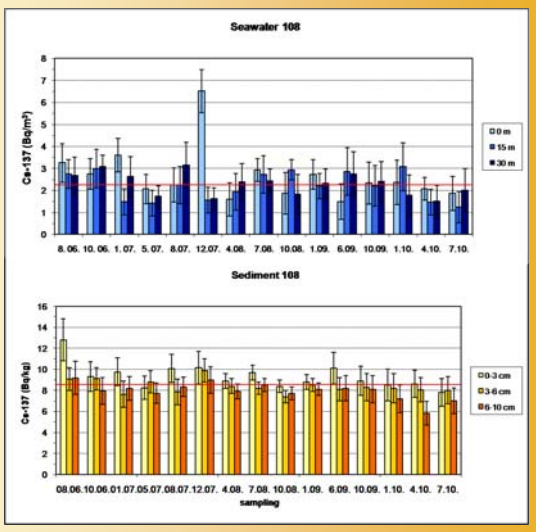

FIG. 3. ^{137}Cs concentrations in seawater at 3 depths (0, 15 and 30 m) and in sediment layer (0-10 cm) at the station 108 from 2006 to 2011.

CONCLUSIONS

A five-year radioecological investigation (2006-2011) was carried out in the northern Adriatic Sea to assess the wide distributins of ^{137}Cs introduced by both direct fallout deposition and the Po river inputs. Artificial radioactivity was assessed by determination of ^{137}Cs concentrations in seawater, sediment and marine organisms. ^{137}Cs concentration in seawater of the northern Adriatic ranges from 1.5 to 3 Bq m^{-3}. *Fucus virsoides* and *Mullus barbatus* could be considered as a good bioindicator for monitoring radioactive contamination in the Adriatic Sea. The radiological status of ^{137}Cs in the northern Adriatic Sea has returned to the pre-Chernobyl values, generally taking into consideration its natural fluctuation due to physical-chemical and hydrological parameters in the investigated area.

References

[1] Cushman-Roisin, B., et al., Physical Oceanography of the Adriatic Sea. Kluwer Academic Publishers (2001). ISBN 1-4020-0225-4.

[2] Nonnis Marzano, F., Triulzi, C. A., Radioecological Survey of Northern and Middle Adriatic Sea before and After the Chernobyl Event (1979-90). Mar. Pollut. Bull. **28** 4 (1994) 244-253.

[3] Papucci, C., Delfanti, R., ^{137}Caesium distribution in the eastern Mediterranean Sea: recent changes and future trends. Sci. Tot. Environ. 237/238 (1999) 67-75.

[4] IAEA, Worldwide marine radioactivity studies (WOMARS) Radionuclide levels in oceans and seas. IAEA-TECDOC-1429, Vienna (2005).

[5] Folsom, T.R., Sreekumaran, C., Some reference methods for determining radioactive and natural caesium for marine studies. IAEA TRS No.118: Reference methods for marine radioactivity studies. Vienna (1970) 129-187.