X-III2

Recent Changes of the Mediterranean Environments - A Research Programme

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Energy consumption and land-use activities have created serious, if not catastrophic, environmental problems during the past century or so. Chemical and radioactive pollution are some examples of modern waste that have created increasing degradation of life qualities. Various degrees of environmental perturbations have been observed in the atmosphere, hydrosphere and the biosphere. The atmosphere is constantly contaminated by chemical waste with different damaging effects. Occasional atmospheric contamination by radioactivity, through failure of nuclear power plants and nuclear-weapon tests, have caused an increasing social and political fear. The greenhouse gases and possible impacts on climate change and landscape ecology have created intensive scientific and political debates. Lacustrine, riverine, estuarine and marine water-bodies suffer eutrophication as well as different forms of chemical pollution (e.g. acidification, heavy metal pollution, oil and organic waste). Soil erosion, dessication of vegetation, salinization, water scarcity and ground-water pollution have also been influenced by modern human activities.

Environmental and historical monitoring are thus important steps in evaluating the quality of present and past environments, and represent a basis for environmental protection policies. Such monitoring programmes would allow: 1) an early warning for environmental instabilities and catastrophic events; 2) global and regional chronological records on past environmental changes. Such knowledge is essential for assessing background values of unpolluted environments as well as for modelling sources, pathways and sinks of environmental pollutants and related interactions in space and time.

Routine and historical monitoring of recent environmental pollution/perturbation are now possible through a set of well-developed techniques covering reliable sampling of environmental materials, low-level counting of natural/artificial radioactivity and chemical/physical analyses of organic and metallic species as well as other palaeolimnological and palaeoecological interdisciplinary approaches. Intensive field studies, considerable international collaboration between specialists/ researchers from different sciences as well as solid social and political support are needed for such complicated and resource-demanding studies.

A research programme "The Mediterranean Pollution History: Radioactive and Chemical Mass-Balance Studies" focusing on modelling the history of modern pollution and its influence on the Mediterranean environments is proposed. This programme (MPH-RCM), however, aims at enriching and building up individual data banks on the history of radioactive and chemical pollution of the Mediterranean countries/regions. This programme would also allow exchanging and integrating scientific and intellectual efforts in environmental, earth-sciences, ecological and management (socio-economic) disciplines. These interactions would provide temporal and spatial correlations between chronologically and environmentally important radioactive nuclides, aquatic nutrients and toxic chemicals. A Mediterranean pollution model in space and time would be constructed. It is hoped that our refined techniques would allow us to evaluate available environmental hypotheses related to land-use and water resources and to understand the nature and dimensions of the confusing environmental issues.

The experimental work within MPH-RCM will primarily concentrate on ^{210}Pb, ^{226}Ra, ^{222}Rn, ^{137}Cs, ^{40}K, ^{90}Sr, $^{239,240,241}Pu$ and ^{241}Am. Nevertheless, some other radioactive nuclides such as ^{14}C, ^{10}Be and ^{32}Si may be considered in some cases. Toxic chemicals such as heavy metals, acid oxides, fluorocarbon, combustion-carbon (aromatic hydrocarbons and soots) and organic-gases, oil and refinery waste, phenols, cyanides, fluorides, synthetic organic chemicals, PCB's, DDT and soil remaining fertilizers have been atmospherically and non-atmospherically injected to the environments at increasing rates during the past century or so. Phosphorus and nitrogen are major nutrients of riverine, lacustrine and marine environments and their enhancement in these environments causes eutrophication, the history of such perturbation would be modelled.

Analyses of the mentioned radioactive and chemical species will be carried out on: 1) air, rain, water, food-stuffs and human organs; 2) depositional sequences with reliable/valuable chronological and environmental records (from undisturbed soils, accumulation bottoms of marine and lacustrine water-bodies as well as suitable wetlands and riverine systems) will be identified, sampled and analyzed. Statistical and modelling tools will be applied to find valid correlations and interactions as well as to construct regional biogeochemical cycles. The influence of climatic, meteorological, hydrological, geophysical and geochemical conditions on biogeochemical cycles will be investigated. The Mediterranean environments would be compared with the Scandinavian ones in order to monitor global trends and to assess the influence of pollution on these very different regions.

X-III3

137 Cs in Marine Organisms - Ten Year Studies in the Greek Marine Environment

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The artificial as well as the natural radioactivity has been studied by radioanalytical methods and direct y-spectroscopy in marine organisms collected from an extended network of 30 stations around the Greek peninsula and the Greek Archipelagos of Aegean and Ionian sea.

The occurence of ^{137}Cs in the Greek marine environment was due to the world-wide fallout, the nuclear ships which were visiting Greece during the past years as well as to the indirect effects from the discharges of the nuclear power stations of the neighboring and Mediterranean countries, until 1986, while since April 1986 the Chernobyl nuclear reactor accident introduced a new load of ^{137}Cs to the marine environment verified by the peaks measured in the marine organisms, few days after the accident (Florou et al, 1987).

Tab. 1. Concentrations of ^{137}Cs (Bq.Kg^{-1}W) in marine organisms from the Aegean and Ionian sea (Greece), 1980-1990.

Algae		**Fish**	
Padina pavonica	0.0-0.4 (1.5)	Sardina pilchardus	0.8-1.4 (6)
Cystoseira	0.0-0.4 (2.0)	Spicara flexuosa	0.2-0.8 (5)
Acetabularia mediterranea	0.06	Boops boops	1.3-2.2 (16) (30)
Jania	0.05 (1.5)	Trachurus Trachurus	0.3-2.3 (2)
Caulerpa prolifera	- (20)	Pagellus erythrinus	0.2-0.5 (4)
Corallina mediterranea	N.D.-0.06(1.5)	Arnoglossus laterna	0.4 (2)
Distyota dichotoma	- (0.2)	Mullus barbatus	0.2-0.3 (5)
Hypnea musciformis	- (0.2)	Merlucius merlucius	0.2-0.4 (3)
Liagora viscida	- (0.5)	Diplodus annularis	- (6, 66)
Sargassum acinarium	0.0 (0.7)	Engraulis encrachicholus	- (5)
Sphaerococus coronopifolius	- (0.8)	Lithognathus mormyrus	- (6)
Codium bursa	- (0.5)	Sparus auratus	- (6)
Stypocaulon scoparium	0.0-0.3 -	Mugil cephalus	- (6,22)
		Micromesistus potassou	- (5)
		Aulopus filamentosus	0.6 -
		Mustelus sp.	1.3 -
Benthic organisms		**Seagrass**	
Mytilus galloprovincialis	0.3 (6, 33)	Posidonia oceanica	0.8-1.0 (2.4)
Paracentrotus lividus	4	Zostera marina	0.5-1.0
Nephrops norvegicus	0.3		
Macropipus depurator	N.D.	Plankton (total)	(2.0)

W : Wet mass
(x) : Values during the period May-October 1986
N.D. : Not Detected

From the overall view of the data one can note that, in general:

- Primary producers shows a low cesium bioaccumulation which is not affected by the species examined (Florou et al, 1985). The Chernobyl radioactive plume provoked an increase of one to two orders of magnitude in the measured values. Caulerpa prolifera is the alga with the greatest value during this time. (Florou et al, 1987). The adult leaves for Posidonia oceanica have been proved as the tissue of the plant, which shows the greatest values of cesium in comparison with the juvenile leaves, shoots and rhizomes (Florou,1989).
- The different feedings habits and habitatas of the measured fish do not seem to affect the bioaccumulation of cesium under the normal conditions, while for the short period after the Chernobyl accident the different ecological and biological parameters have affected the observed bioaccumulation. Boops boops, Diplodus annularis and Mugil cephalus have showd elevated values of cesium in some stations (Florou, 1987a). The values measured after the accident have increased up to one order of magnitude for a short period, while since 1987 they have been in the same range as before the accident (Florou et al, 1987b).
- Mytilus galloprovincialis, which is known as the mussel watch (Forstner and Wittman 1979), have showed an early response to the cesium impact which has varied according to the ecological parametrs of the sampling stations (Florou et al, 1987a).
- The different synthesis of plankton samples have showed various concentrations of cesium, with the great values in the samples with the phytoplankton as the major part (Florou,1989).
- From the different taxa examined, fish have showed the greatest values of cesium, espesially during the period of the radioactive plume influence.
- It could be necessary for the assessment of the cesium global inventory to the Mediterranean sea, in the framework of GIRMED, some organisms to be established as indicators for the cesium bioaccumulation. Nevertheless, the selected bioaccumulation of cesium among the different organisms should be the main parameter for the choice of the organism-indicators.

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X