FECS Division for Chemistry and the Environment (FECS DCE)

Environmental Education and Research in Greece*

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Introduction

Following an invitation of 'ESPR - Environmental Science and Pollution Research' to the members of the FECS Division for Chemistry and the Environment to give an account for the development of the field of Chemistry and Environment in the FECS member countries, this report presents the status and ongoing development of Environmental Science and Education in Greece. Similar reports have already been published from several FECS member countries such as Spain [1], Italy [2] and Hungary [3] while other related issues have also been addressed [4,5]. Within this framework, this report presents the most important issues related to Environmental Education and Research in Greece. The discussion is focused on the post-graduate level environmental education and on issues related to the research activity as currently applied and practiced by Greek scientists.

In 1986, Greece adopted its first integrated institutional law for the protection of the Environment. According to this law, the protection and preservation of the natural environment is an obligation of the state. Its initial objectives were the protection of the environment to ensure human health and development.

Since then, and in accordance with the EU directives, additional rules and edicts have been added to reinforce the initial law. The law for Environment as applied today can be classified in seven parts [6]:

- Environmental Protection (including Environmental Impact As-1. sessments).
- Management and Protection of Aquatic Resources (water qual-2 ity, Domestic and Industrial Liquid Wastes Disposal, Limits of Pollutants),
- Management of Solid Wastes, 3.
- Atmospheric pollution (including allowed limits and permitted forms of fuels for industries),
- Toxic and Hazardous Wastes (including allowed limits),
- Noise pollution (and potential hazards) and
- Protection of Natural Environment (preservation of wild life and 7. biodiversity-including international contracts as The RAMSAR contract)

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mental issues of our times, have been established. Education

1.1 Graduate studies

In almost all Greek Universities there are departments directly or indirectly related to Environmental Science. Traditional departments as Chemistry, Physics, Biology, Geology and Engineering Departments all contain curricula concerning environmental science, technology, engineering and ecology. The emphasis of education in these departments is usually given to environmental science in the framework of optional and compulsory selective courses while less obligatory courses are usually offered to deal with the issue of Environmental-Scientific Education [7]. Due to the fact that Environmental Science is a combination of many traditional scientific courses, these courses are adjusted to the basic curricula of each department so as to exhibit their application in the field of environment. Curriculum requirements and teaching resources for these courses differ from one university to another. In the University of Athens for example, there are two courses on Environmental Chemistry. In the first, General Environmental Chemistry, issues like the basic principles of environmental science, soil chemistry, sources of pollutants, water chemistry, atmospheric chemistry and the effects of pollutants are addressed. In the second course, entitled Special Environmental Chemistry issues like photochemical pollution, cleaning technologies, solid wastes, recovery & recycling, toxic wastes, liquid wastes, the chemistry of burning fossil fuels and advanced analytical chemistry, are covered [8]. Moreover, the possibility of specialization in the field of Environmental Science (and with respect to the department's orientation) is also offered in most cases.

The establishment of environmental protection within Greece's

institutional obligations and following the worldwide grow-

ing concern for environmental protection, simulated a con-

tinuously growing research activity on the field of Environ-

mental science. In this framework, educational structures for

the training of scientists, able to deal with the major environ-

Additionally, the last few years special attention has been given to establish departments which will directly deal with Environmental Science [9]. As a result a variety of departments have been established. The department of Environmental Studies at the University of Aegean, the Department of Environmental Management and Natural Resources at the University of Ioannina, the Department of Forestry and Natural Environment in the University of Thessaloniki, the Department of Environmental Engineering at the Dimokritio University of Thrace and at the University of Crete.

Following this trend, 4-year university levels courses named 'Extended Education Courses' are offered in specified areas as Agro-Ecology at the University of Ioannina and Environmental Cartography at the University of the Aegean.

1.2 Post-graduate studies

The need for scientists, properly trained to deal with the environmental problems and issues arising from the development of Greece and the international perspective for environmental protection, stimulates a great number of post-graduate studies at all universities from M.Sc. to Ph.D levels. As a result postgraduate courses related to all fields of environmental science have been established. **Table 1** presents the Post-Graduate studies offered by Greek Universities.

Post-graduate level Environmental Research is performed by many Departments (not included in Table 1.) For example,

Table 1: Post-Graduate Courses on Environmental Sciences Offered in Greek Universities

University	Department	Post-Graduate Course Title (M.Sc. and/or Ph.D level
University of Athens	Dept. of Plant Production	Plant Protection
,	Dept. of Biology	Plant Physiology
		Ecophysiology of Mediterranean Plants
		Biological Oceanography
		Oceanography (a)
	Dept. of Natural Resources Exploitation & Agricultural	Agricultural Engineering
	Engineering	······································
	Dept. of Mathematics	Biostatistics
	Dept. of Chemistry	Environmental Chemistry & Technology
Aristotelian University of	Dept. of Geology	Chemical Oceanography
Thessaloniki		Hydrogeology
		Mineral Resourses and Environment
		Climatology and Meteorology
		Applied and Environmental Geology
		Geochemical Pollution of the Environment
		Geological Oceanography
		Geosciences and the Environment
		Geography and the Environment
	Department of Chemistry	Environmental Chemistry
	Department of Biology	Hydrobiology and Aquaculture
		Environmental Biology
		Environmental Sciences
		Ecological Management and Environmental Technology
		Marine Biology - Fishery and Aquaculture
		Basic Biology: Ecology
	Dept. of Agronomy and Topographical Engineering	Aquatic Resources
	Dept. of Civil Engineering	Environmental Protection and Sustainable Development
		Science and Technology for Aquatic Resources
	Dept. Mineral Resources Engineering	Environmental Geotechnology
	Dept. of Agronomy (Geoponics)	Ecology Management of Agroecosystems
	Dept. of Ship Mechanics and Engineering	Navy and Marine Technology and Science (a)
	Dept. of Chemical Engineering	Energy and the Environment
		Bioecology - Technical Development
	Dept. of Forestry and Natural Environment	
	General Department	Analytical and Environmental Chemistry
	Dept. of Physics	Environmental Physics
National Technical	Dept. of Architecture	Monument Protection (a)
University of Athens	Dept. of Agronomy and Topographical Engineering	Environment and Development
(Ethniko Metsovio	Dept. of Civil Engineering	Science and Technology f Aquatic Resources (a)
Politechnio)		
Agronomic University of	Dept. of Natural Resources Exploitation & Agricultural	Natural Resources Exploitation & Agricultural Engineering
Athens	Engineering	
University of Ioannina	Dept. of Mathematics	Biostatistics
· · · · · · · · · · · · · · · · · · ·	Dept. of Physics	Meteorology and Climatology
University of Crete	Dept. of Biology	Management of Marine and Terrestrial Resourses
Technical University of	Dept. of Mineral Resources Engineering	Environmental Geotechnology
Crete	Dept. of Environmental Engineering	Quality Control and Environmental Management (b)
	Dept. of Electronics and Computer Engineering	Renewable Sourses of Energy
Xarokopio University of	Dept. of Home Economics and Ecology	Sustainable Development
Athens		
University of Thesalia	Dept. Industrial Mechanics & Engineering	Contemporary Methods in Energy Systems and Remedation
		Technologies
	Dept. of Spatial Engineering and Regional Development	Spatial & Urban Planning, and Regional Development
		Environmental Planning and Sustainable Development
	Dept. of Agronomy (Geoponics), Plant and Animal Production	Contemporary Systems in Agricultural Production in The
		Mediterranean
University of Aegean	Dept. of Environmental Studies	Environmental Science
		Politics and Planning in Environmental Sciences
		Environmental Politics and Management (b)
(a) Courses offered in co-operati	on between different depertmente (inter depertmental sources)	

(b) Courses offered in co-operation between different Universities (inter-university courses)

the post-graduate course of Chemistry in the Department of Chemistry at the University of Ioannina, offers the possibility of M.Sc. or Ph.D. degree in Environmental Chemistry or Environmental Chemical Technology.

1.3 General education

The Greek Chemical Society has established short courses related to environmental problems. Such courses given so far include Environmental Microbiology, Toxic Industrial Waste, Domestic Waste and Treatment Technologies of Liquid Waste. Furthermore, other organizations and scientific societies are also involved in training young scientists and technologists on different topics of the environmental science and technology [7].

Moreover, the Institute of Continuing Training, under the shield of the National Center of Public Administration, trains on a continues basis public employees and administrators in new concepts, technologies and legislation related to environmental topics important for the implementation of the European Environmental Policy. In 1994-95 for example, the following topics, through intensive courses in different cities in Greece (lasting two weeks-100 hours), have been covered [7]: Management of Water Resources, Pollution and Technologies for the Protection of the Environment, Natural Environment and Natural Risks, Environmental Management, Assessment of Environmental Impacts.

2 Research

In general terms, research on the field of Environmental Science is carried out at [10]:

2.1 Research institutes - centers

Some of the research institutes active in research in Greece are:

- The NCMR (National Center for Marine Research). The NCMR is a governmental research institution whose aim is the scientific research of the hydrosphere with the living and non-living organisms. It performs studies on the physical boundaries with the atmosphere, the bottom and coastal areas, oceanography, benthic studies and environmental analysis.
- The MARTEDEC (Marine Technology Development Company). The main scope of MARTEDEC is to contract research and development projects and to provide services in the marine technologies (i.e maritime transport, ocean and environmental engineering) as well as the field of port and coastal engineering.
- The IMBC (Institute of Marine Biology of Crete). The IMBC is a semi-indepentend research and technology organization in marine biology. It performs research on issues of aquaculture, fisheries, marine ecology, management of coastal resourses, biological oceanography, remote sensing, and molecular biotechnology.
- The I.G.M.E. (Institute of Geology and Mineral Exploration). The basic objectives of IGME are the research and study of the country's geological structure, the location and evaluation of the mineral raw materials (except

hydrocarbons) and geothermal fields and the exploration and exploitation of the water resources with special emphasis to the environmental protection. The work field of IGME includes almost the whole range of Geosciences and specifically it carries out geological, hydrogeological, engineering geological, geophysical, geochemical, mineralogical studies, mineral and mining explorations as well as projects aiming at the location of ore deposits, aggregates and industrial minerals.

• The National Center for Scientific Research Demokritos (NCSRD). The Center is the largest in Greece and commits itself to serving industrial, environmental and social needs providing advanced R&D services. The R&D group of Environmental Research Laboratory (*EREL*) has been at the forefront of environmental computational fluid dynamics while developing experimental infrastructure for the measurement and analysis of a variety of pollutants. In particular, *EREL* has gathered advanced expertise in the field of atmospheric dispersion modelling, air-ground interaction and air quality measurements over the last 15 years.

Other research centers and institutes, active in research in Greece, are the Aquaculture Center of Acheloos, the National Research Institute (NRC) the Nestor Institute (Institute for Deep Sea Research and Neutrino Astroparticle Physics), and the Fisheries Research Institute.

2.2 Universities

Many research groups in university laboratories, which are usually funded from EU or national programs in the field of the environment, also perform environmental Research in Greece. Traditional research in Greek universities includes monitoring of pollutants in the ecosystems, development of new environmental analytical techniques and engineering, while some toxicological issues have also been addressed. Quite recently, other areas of research have been developed such as environmental technology, biotechnology, bio-mechanics, biodiversity, environmental management and economics, etc. Some examples of the research activity on environmental chemistry in Greek Universities are presented in Table 2.

2.3 Private, semi-private or associated public-private institutes

Although the environmental research activity in the private sector is not much developed in Greece there are some organizations or institutes, which are working on subjects related to Environmental Science and Research. These include the municipal enterprises of water supply and sewage and a few laboratories or institutes, which are usually incorporated in Industries. Their research is basically focused on technical or more likely on technological activities.

3 Funds

Funds for environmental research are granted from the General Secretariat of Research and Technology (GSRT) of the Ministry of Development and from European Union projects. NATO-GSRT grants have also been supplied while funds from Industries are obtained occasionally. A few ongoing or

UIIIVELSKY	Department	
University of Athens	Chemistry	Air Pollution (indoor and outdoor) • Volatile Organic Compounds (VOC's) • PAH's • PCB's • Carbonyl Compounds • Acid Rain • Heavy Metals
		Water Pollution
		Heavy Metals PAH's
University of Thessaloniki	Chemistry	Air Pollution • PAH's • Acid Rain • House Metals
		Water Pollution • PAH's • Heavy Metals • Surfactants
University of Ioannina	Chemistry	Air Pollution (indoor and outdoor) PAH's Heavy Metals Water Pollution Pesticides
		Heavy Metals
University of Crete	Chemistry	Air Pollution PAH's Heavy Metals Water Pollution
University of Patras	Chemistry	Air Pollution VOC's Secondary Photochemical pollutants Acid Rain
University of Aegean	Environmental Studies	Air Pollution • Heavy Metals Water Pollution • Heavy Metals • Pesticides • PAH's
University of Thessaly	General Department	Water Pollution Pesticides

Table 2: Research Activities on Environmental Chemistry in Greek Universities

recently concluded research projects financed or co-financed by the GSRT are:

- 1. NATO/CCMS Pilot Study 'Industrial and Toxic Wastes Management and substances research'
- 2. Migration of anthropogenic impurities of toxic elements, halogen-organic substances, oil products and phenols in surface and drinking waters
- 3. Solidification-stabilization of wastes from metal industries
- 4. Survey of the wastewater management in Bulgaria
- 5. Actions in the treatment and reuse of treated wastewater and sludge in South Mediterranean and Middle East Countries

EU projects performed by Greek University laboratories or institutes are MEDPOL, EUROPEROX, ENVIREG, EN-VIRONMENT, etc.

4 **Publications**

Some journals where original papers on Environmental Science have been recently published from Greek authors are presented here.

Analytical Chemistry Journals

- Analytica Chimica Acta
- The Analyst
- Journal of Analytical Atomic Spectrometry
- Journal of Chromatography A

Environmental Science Journals

- Environmental Science & Technology
- Chemosphere
- ESPR Environmental Science and Pollution Research
- Environmental and Health Science Online (EHS-Online)
- Marine Chemistry
- The Science of the Total Environment
- Fresenius Environmental Bulletin
- Atmospheric Environment
- Journal of Environmental Chemistry and Toxicology
- Journal of Degradation and Biodegradation
- Water Research
- Water Science and Technology

- Environmental Technology
- Toxicological and Environmental Chemistry
- International Journal of Environmental Analytical Chemistry
- Environment International
- Journal of Environmental Science and Health, Part A Toxic/ Hazardous Substances & Environmental Engineering

A search to four publishing companies revealed a great number of recent publications from Greek authors, in the field of Environmental Science Research. An indicative evaluation with respect to each sector of environmental research is presented in Fig. 1¹.



Fig. 1: Environmental Research in Greece

5 Scientific Meetings

Following the above mentioned increasing interest and research activity in Greece on issues related to Environmental Science, there is an increasing trend for the organization of Conferences and Workshops in this field of research. Some examples are:

- The Conference on 'Environmental Science and Technology' held every two years since 1989 on courtesy of The Department of Environmental Sciences, University of Aegean
- The Scientific Yearbook of the Department of Forestry and Natural Environment held in Thessaloniki 1995
- International Conference on 'Environment and Society: Education and Public Awareness for Sustainability', Thessaloniki, Greece, 8-12 December 1997
- The 1st Conference on 'Pesticides and Relative Organic Compounds in the Environment', Ioannina, 5-8 October 2000
- 8th FECS Conference on 'Chemistry and the Environment', to be held in Athens (Greece) from 1 to 4 September 2002

Many conferences on Chemistry, Physics Biology, Ecology etc, organized by Greek institutions (universities, research institutes, governmental organizations etc), include sessions on environmental issues.

6 Organizations

Recently, environmental organizations with international and transboundary character have been established:

• The Global Nest. An association for scientists, technologists, engineers and others concerned with the study of environmental science and technology and of the environment generally, and of the application of such knowledge to the development of sustainable solutions. The Network has wide-ranging aims and objectives which cover:

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- advancing the study of environmental science, technology and policy
- the widest-possible dissemination of knowledge in the fields of environmental science, technology and policy
- exchanging information between academics and between academia, business, industry, policy makers and the general public
- bringing together scientists, technologists, engineers and others for discussion on areas of concern
- influencing policy makers, business leaders and the general public
- liaising with and cooperating with other organisations worldwide with similar aims and objectives

As part of the network's efforts for environmental protection a scientific journal has been established. *The Global Nest International Journal* published its first issue in 1999.

- The Balkan Environmental Association (B.EN.A). A nonprofit organization, in accordance with European Union law regulations for non-profit organizations. The objective of B.EN.A is to bring together its members and other interested persons from scientific political or economical domains, in order to examine the current problems of environmental protection in the Balkan region and investigate solutions to these problems on regional, national and international basis. Its objective is also to give suggestions and recommendations concerning environmental quality and safety so as to enable the regulatory bodies of the various Balkan Countries to take proper decisions regarding the evaluation of the risk of chemicals and physical agents. The aims of B.EN.A are:
- Development of international co-operation on reducing of the transboundary pollution (air and water). Development of air and water quality assessment and improvement through collaboration among affected countries.
- Development of strategies and options for environmental protection of Balkan rivers and lakes.
- Wetland quality monitoring.
- Development of the environmental quality management system for the region.
- International research projects for neighbouring countries regarding the cross-border pollution.
- Development of international programmes for restoration and sustainable improvement of ecological safety of cross-border regions.
- Establishment of, an integrating framework for the support of local and international environmental issues.

B.EN.A has recently moved forward with the establishment of a scientific journal entitled *Environmental Protection and Ecology*. The journal published its first issue in 2000.

7 Conclusions

The particular characteristics of Greece's natural environment (extended coastal areas, unique and protected species) and the indissoluble linkages between economic activities and natural resources, in combination with the worldwide growing concern for environmental protection, initiated a wide activity on issues related to environmental protection in Greece. Following the establishment of legislation for environmental protection and preservation, Greece has undertaken significant steps in research areas related to environmental chemistry, technology, engineering, biotechnology, management and ecology. This continuously growing

¹ This is only a general estimation derived from a rough search in 4 publishing companies. It does not provide accurate quantitative information on the environmental research in Greece but only shows a general trend.

research activity is closely followed by an expanding educational framework, which aids to the training of experts and scientists able to deal with the major (national and transboundary) environmental issues of our times.

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First Announcement and Call for Papers

8th FECS Conference on Chemistry and the Enviroment: Chemistry for a Sustaining World Athens, Greece, 31 August to 4 September 2002

Conference website: http://www.scientificjournals.com/espr/fecs/8thConf.2002

Under the auspices of: 1. FECS-DCE, 2. The Association of Greek Chemists, 3. ecomed publishers

Organized by the University of Athens, Department of Chemistry

Conference Aims

To fulfil its part in sustainable World development, chemistry is changing. This 'greening' of chemistry involves two main thrusts. **First**, production, use and disposal of hazardous chemicals is being reduced and where possible eliminated. This must, however, be achieved whilst maintaining or improving the quality of human life, the natural environment and industrial competitiveness. **Second**, the environmental impact of anthropogenic chemicals is being studied so that it may be better understood, monitored and controlled.

Research is continuing to support these goals. New synthetic pathways are being developed using renewable feedstocks, alternative solvents, catalysts and reaction conditions to increase energy and atom efficiency and reduce waste. Simultaneously the toxicology, metabolism and biogeochemical cycling of environmental contaminants and pollutants are being elucidated.

Although sustainability in chemistry has become established in many

parts of the industry, there is still a lack of general awareness amongst academics, industrialists, regulators and the media.

The aim of this conference is to bring together scientists from universities, industry and governments

- to discuss and promulgate the current state of knowledge, latest research findings and likely future developments in all aspects of chemistry in the environment
- to point the way to an integrated approach to chemistry for a sustainable and sustaining world in the twenty-first century.

The conference will include invited plenary lectures from world authorities, parallel sessions of oral presentations of submitted papers arranged to cater for both specialist and generalist participants, dedicated workshops and exhibitions of commercial laboratory and field equipment.

A special session will be devoted to the **2004 Olympic Games** and its potential impact on the city of Athens.

Preliminary Program

1. Air Quality and Exposure (Chairs: Hartmut Frank, Herman van Langenhove) 2. Water and Sediment Quality and Treatment (Chairs: Fritz Frimmel, Maria Teresa Vasconcelos) 3. Soil Quality and Remediation (Chairs: Toomas Tenno, Costas Michael) 4. Anthropogenic Chemistry (Chairs: Valery S. Petrosyan, John Holder) 5. Environmental Management (Chairs: Allan Astrup Jensen, Sergio Facchetti) 6. Education in Environmental Chemistry (Chairs: Uri Zoller, Miltiades I. Karayannis) 7. Olympic Games and the Environment (Chairs: Panayotis Siskos, Ramon Mestres) 8. Conservation of Ancient Monuments (Chairs: Luciano Morselli, Nikos Katsanos) Suggestions for further topics and speakers are welcome Call for Abstracts: Deadline for abstracts is March 2002 Registration fee: Participants: 300 Euro; graduate students: 100 Euro Pre-registration: online by the website or by using the pre-registration form Accomodation: www.eot.gr Contact: Panayotis A. Siskos Assoc. Professor of Analytical Chemistry and Environmental Analysis Department of Chemistry, University of Athens Panepistimiopolis-Zographon, Athens 15771, Greece T: +301-727-4311; F: +301-727-4750 e-mail: siskos@chem.uoa.gr; info@eex.gr; Websites: http://www.siskos.gr; http://www.eex.gr The abstracts will appear as a Special Issue of Environmental Science and Pollution Research