



International Union of Pure and Applied Chemistry

A member of the International Council of Scientific Unions

Division of Chemistry and the Environment (DCE - VI)

Report of Activities

January 2006 – June 2007

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1. HIGHLIGHTS

1.1 Terms of Reference

Through its internationally recognized membership and project teams, the Division of Chemistry and the Environment (DCE) will provide unbiased and timely authoritative reviews on the behavior of chemical compounds in food and the environment. The DCE will undertake both fundamental and applied evaluations that contribute to solving environmental problems and enhancing the quality of food on a global scale.

1.2 People

The Division Committee (DC) is currently comprised of 10 TM's, 7 AM's, and 7 NR's.

The membership (24) of the DC for the current biennium includes representatives of 20 countries, with each region of the globe well represented with the exception of Latin America. The DC includes 5 women and 2 representatives from scientifically emerging countries.

The Division recently held the balloting process for open TM positions and future officers, and Prof. Nicola Senesi has been chosen as the new Division President for a term to begin in January 2008. He will succeed existing DP Dr. Kenneth Racke, who will move to the Past President role. The DC is currently in the process of selecting AM's and NR's for the 2008-2009 biennium, and expects to complete the process prior to the Torino GA.

The work of the Division Committee is assisted by the efforts of several sub-committees, which help identify new priority project areas, stimulate proposals and recruit potential project leaders, and facilitate external communication encompassing the broad areas of environmental and food chemistry:

- Biophysico-Chemical Processes in Environmental Systems (Chair: Prof. Nicola Senesi)
- Chemistry of Environmental Compartments (Chair: Dr. Yehuda Shevah)
- Crop Protection Chemistry (Chair: Dr. Ken Racke)
- Food Chemistry (Chair: Open)

1.3 Projects

Projects sponsored by the DCE generally fall into three broad categories. First, state-of-the-art **authoritative reviews** of a particular area of environmental chemistry are developed and published in book form. To this end, the Division has a long-standing working partnership with Wiley Press. Second, **technical evaluations** focus on critical assessment and development of specific recommendations for an area of environmental or food chemistry so as to assist and influence research and public policy. Primary areas of emphasis include definitions, methodologies, and regulations. Third, **outreach** activities help move IUPAC project outcomes outside the small circle of specialists and into the broader scientific and regulatory arena, with a strong emphasis on technology transfer to developing countries. These outreach activities include both regional workshops and international congresses that maintain a high level of IUPAC involvement and serve to highlight ongoing and completed IUPAC projects.

At the beginning of the 2006-2007 biennium there were 22 active projects, including 4 that were interdivisionally sponsored (Appendix I). Of these 22 projects, 7 have been completed with reports published or in-press, 2 moribund projects have been or will be soon abandoned, and 4 projects are nearing completion. Most of the 9 remaining projects are demonstrating good progress, although 2 of these have asked for formal extensions.

Since January of 2006 a total of 10 new project proposals have been approved, and an additional 2 project proposals are under review with funding decisions expected by the time of the Torino GA (Appendix II)

2. DIVISIONAL ACTIVITIES

Examples of some of the project activities of DCE during the reporting period are provided below in relation to several of the long-range goals established by IUPAC. This is only a sampling, but should provide insight into the project areas of greatest involvement for the Division.

2.1 IUPAC will provide leadership as a worldwide scientific organization that objectively addresses global issues involving the chemical sciences.

- ***Remediation Technologies for Removal of Arsenic from Water and Wastewater*** (2003-017-2-600). The impetus for this project is the already apparent toxicity of water supplies in several regions through natural arsenic contamination affecting the health of millions of residents. There is an urgent need to reduce arsenic levels in drinking water supplies and, in some areas, irrigation waters. Although several technologies have been proposed, there has not been sufficient in-depth evaluation especially for routine treatment of large volumes of water, and agreement on assessment criteria is also lacking. This project is addressing these important issues and includes collaboration with WHO and other IUPAC initiatives in this area including CHEMRAWN. A final report outlining the issue, providing a critique of remediation technologies, and containing case studies for Bangladesh and Thailand has been completed and is soon to be published as a special volume in the series *Reviews of Environmental Contamination and Toxicology*.
- ***Impact of Transgenic Crops on the Use of Agrochemicals and the Environment*** (2001-24-2-600) and ***Evaluation of Food and Feed Safety Implications of Altered Residues of Pesticides Applied on Transgenic Crops*** (2006-015-3-600). Production of a sustainable global food supply has for the past 60 years relied upon a combination of cultural, biological, and chemical

pest management tools. The recent introduction of transgenic crops containing genetic modifications for pest resistance or pesticide tolerance across millions of hectares of agricultural land has raised worldwide interests and significant differences of views between countries as relates to potential environmental and human health impacts. These two active projects are providing unbiased and authoritative international views to these areas of concern based on scientific assessment methodology, and provide an opportunity for IUPAC to take an important leadership role in promoting the importance of chemistry in applied molecular biology. The first project, emphasizing environmental impacts was initiated during 2002 and final report is in press. The second, follow-up project was initiated during 2007 to address primarily human health aspects.

- ***Air Pollution Models in Environmental Management and Assessment*** (2003-058-1-600). The Division has had a historical strength related to atmospheric chemistry and air pollution considerations. Air pollution models are powerful and necessary tools in environmental management programs, and allow predications. The aim of this project is to describe the methodology behind application of mathematical models in various assessments of air pollution impacts. The outcome of the project will be a technical guidance book describing key approaches and providing guidelines for avoiding incomplete or even incorrect answers when models are applied.
- ***XII International IUPAC Symposium on Mycotoxins and Phycotoxins, Istanbul, Turkey (May 2007)***. Although much scientific and public attention is directed at chemistry and human exposure aspects of synthetic chemicals in food, natural toxins are far more prevalent and potentially impactful for the majority of the world's population. IUPAC has had a long-standing interest in mycotoxins and phycotoxins, and this symposium was only the latest in a series that has become the premiere forum for exchange of research results and methodologies related to these important naturally occurring toxins. The traditional strength of IUPAC as related to the chemistry aspects of these biotoxins has been an important factor in the success of this series. A report of the outcome of this XII symposium held in Istanbul, Turkey will be available by the time of the GA in Torino, and plans are being discussed for location and timing of the XIII symposium.

2.2 IUPAC will facilitate the advancement of research in the chemical sciences through the tools that it provides for international standardization and scientific discussion.

- ***Glossary of Pesticide Chemistry*** (2004-002-1-600) and ***Global Availability of Information on Agrochemicals*** (2001-022-1-600). Availability of standardized definitions of key terms and ready access to the latest technical information regarding pesticides and other agrochemicals are critical for supporting both research and regulatory evaluation activities. The recently published "pesticide glossary" provides an authoritative update of an IUPAC report of 10 years earlier, and it was developed with the collaboration of scientists from WHO, FAO, and OECD to ensure the broadest acceptance and applicability. The "global availability" project is aimed at increasing global availability of information on the chemistry of agrochemicals, including methods for testing and evaluation, summaries of properties for individual pesticides, and regulatory standards for pesticides. An internet-based approach developed in cooperation with the FAO-IAEA INFOCRIS program has been pursued, and a web-site launch is anticipated by the end of 2007.
- ***Terminology and Measurement Techniques of Starch Components*** (2004-022-3-400) and ***What are Dietary Fibres?*** (2007-017-1-000). During the past several years the Division has

been reinvigorating activities related to food chemistry and has launched several new projects. The “starch” project is aimed at providing internationally needed guidance on the terminology for these very important food components of the complex carbohydrate class. Starches present a number of difficult issues relating to both terminology and methods for determination which are of importance to nutrition, food quality and international trade. The soon-to-be-initiated “dietary fibres” project will characterize the nature of dietary fibres and how they are altered as a result of food processing, and plans to offer a clear set of internationally accepted definitions.

- ***Use of Reference Soils for Testing Fate and Effects of Chemicals*** (2001-026-1-600). There is difficulty comparing results of environmental tests on the behavior of chemicals due to the use of different soils with various physical, chemical, and biological characteristics. This project aims to develop recommendations related to selection of standardized, reference soils so as to allow greater comparability of tests conducted on different chemicals and in various laboratories. This project is nearing completion.
- **Wiley-IUPAC book series “Analytical and Physical Chemistry of Environmental Systems”**. Professor Nicola Senesi provides the impetus at the Divisional level for the continuing publication of this series of multi-chapter critical-reviews (Series Editors: J. Buffle and H. Van Leeuwen). No. 9 in the series “*Physicochemical Kinetics and Transport at Chemical-Biological Membranes*” was published in 2004. Two current projects are producing volumes No. 10 “*Environmental Colloids: Behaviour, Structure and Characterisation*” (2004-015-1-600) and No. 11 “*Biophysico-Chemistry of Fractal Structures and Processes in Environmental Systems*” (2003-014-2-600). A new **Wiley-IUPAC book series on “Physico-Chemical Processes in the Soil Environment”** has recently been initiated. The first volume will be produced by the end of 2007 based on the project “*Biophysico-Chemical Processes of Heavy Metals and Metalloids in Soil Environments*” (2004-003-2-600). A second volume is now being initiated via the project “*Biophysico-Chemical Processes Involving Natural Nonliving Organic Matter in Environmental Systems.*” (2006-014-1-600). The highest academic standards are being maintained in both these book series through the careful selection of the chapter authors and thorough review and editing procedures. This ensures the credibility of IUPAC remains in these areas of environmental physico-biological chemistry.
- ***Combination of Chemical Analytical Measurements and Remote Sensing Techniques for Coastal Water Monitoring.*** (2006-049-2-600). The objectives of this recently initiated project are to record the state of the art in remote sensing techniques and methods used for marine environment monitoring, and to assess the potential combination of remote sensing data with in situ and laboratory monitoring. Case studies based on the Eastern Mediterranean and Black Sea regions will be developed.

2.3 IUPAC will foster communication among individual chemists and scientific organizations, with special emphasis on the needs of chemists in developing countries.

- ***Standardization of Analytical Approaches and Analytical Capacity-Building in Africa*** (2004-017-1-500). This is a cooperative project with the IUPAC Analytical Chemistry Division, the International Organization for Chemical Sciences in Development (IOCD), and the Association of Official Analytical Chemists International (AOAC). Uganda and Kenya are the initial focus, with Nigeria, South Africa, and Mozambique of future interest in conjunction with an ongoing World Bank project. The project aims to build regional analytical laboratory capabilities in relation to monitoring and enforcement of international trade standards. Key activities will

involve lectureships, local workshops, visiting scientist apprenticeships, and laboratory equipment procurement initiatives.

- ***Development of Simplified Methods for Ecological Risk Assessment of Pesticides*** (2004-011-1-600) and ***Environmental Risk Assessments for the Registration of Pesticides used in Rice Paddy Fields*** (2006-044-2-600). Risk assessment involves integration of chemical exposure information with effects data to determine the likelihood of adverse effects. Scientists and regulatory authorities in developing regions increasingly wish to rely on this advanced approach in order to make informed risk management decisions related to the use of pesticides, and IUPAC is developing guidance on application of these principles within the agricultural context and level of information available in these countries. The “simplified methods” project addresses a critical gap that now exists between the highly sophisticated and resource-intensive approaches to risk assessment practiced in some developed countries with the unreliable or non-scientific consideration of exposure and risk that plagues many developing countries. A project team consisting of leading government, industry, and academic modellers and risk assessment experts has been assembled to make rapid progress. The recently initiated “pesticides in rice” project aims to develop a specific framework for assessment of pesticides for use in this highly important crop.
- The ***IUPAC International Symposium on Mycotoxins and Phycotoxins*** has been hosted for more than 30 years. The XI IUPAC International Symposium on Mycotoxins and Phycotoxins, was held in Maryland, USA, during May 2004 and the XII Symposium was just completed in Istanbul, Turkey during May 2007. These symposia typically attract more than 300 participants from 40+ countries, and are only the latest in a long-standing series that has become the premiere forum for exchange of research results and methodologies related to these important naturally occurring toxins. The traditional strength of IUPAC as related to the chemistry aspects of these biotoxins has been an important factor in the success of this series.
- ***IUPAC Regional Crop Protection Chemistry Workshops***. During the past 15 years the Division has sponsored a series of regional workshops focused on broadening the adoption of harmonized, international approaches to crop protection chemistry research and regulation in developing countries. The workshops create a forum where IUPAC project outcomes as well as recommendations from other international bodies can be discussed and applied within the context of local environmental problem areas. Following successful sessions in China, Thailand, Taiwan, Brazil and Korea, the 6th workshop was held in San Jose, Costa Rica during February 2005 as part of the project ***Crop Protection Chemistry in Latin America: Harmonized Approaches for Environmental Assessment and Regulation*** (2003-013-1-600). Follow-ups to the 2005 workshop (250 attendees from 28 countries) have included smaller training sessions (20-30 experts) during 2006 and 2007 on priority topics (human and environmental risk assessment, establishment of product quality standards), and a Latin-Americanized, Spanish version of the influential text “*Pesticides in the Environment*” is being prepared for release in 2008. The 7th workshop is planned for Beijing, China during October 2007 as part of the project “*Crop Protection Chemistry in Asia: Harmonized Approaches for Safety Evaluation, Regulation, and Protection of Trade*” (2006-017-2-600).
- ***Lecturers on Environmental Chemistry Topics***. The Division is becoming more active in identification of important conferences for IUPAC sponsorship and planning for involvement of IUPAC Lecturers. The objectives for involving the IUPAC Lecturers are to publicize relevant findings of recently completed IUPAC Projects and to recruit new project proposals and task group members from scientifically emerging regions. Two IUPAC lecturers from Canada and

New Zealand have been selected by the Division for presentation of plenary lectures at the *International Symposium of Interactions of Soil Minerals with Organic Components and Microorganisms* to be held in Pucón, Chile during November 2008. The lecturers will also visit local universities to provide more detailed presentations. Three IUPAC lecturers from Australia and USA have been proposed by the Division for presentation of plenary lectures at the *First International Conference on Agrochemicals Protecting Crop, Health, and Natural Environment* planned for Delhi, India during January 2008. Additional lectures at universities would follow.

- The *IUPAC International Congress of Pesticide Chemistry* has been hosted for more than 40 years. The 11th IUPAC International Congress of Pesticide Chemistry was held during August 2006 in Kobe, Japan, and it was co-organized with the Pesticide Science Society of Japan (PSSJ). More than 1100 chemists from 52 countries participated in the Congress, which was organized around the theme “Evolution for Crop Protection, Public Health, and Environmental Safety”. The core of the scientific program consisted of welcoming speeches on behalf of PSSJ and IUPAC, 5 keynote addresses, more than 100 invited lectures, and nearly 600 posters. The Congress included an outreach program to consumer groups and the media which drew nearly 400 additional, non-chemist participants. Two strong bids for future Congress locations were received, and the Division recently agreed to organize the 12th IUPAC International Congress of Pesticide Chemistry for July 2010 in Melbourne, Australia in cooperation with the Royal Australian Chemical Institute.

3. BUDGET (as of 1 June 2007)

For the 2006-2007 biennium the Division was granted \$68,000 total budget. Of this, \$18,916 or 27.8% has been spent on operations, mostly to subsidize travel of AM's and NR's to attend the annual DC meeting in 2006. So far, a total of \$36,750 or 54.0% has been committed to funding of newly approved projects. It is anticipated that most of the remaining Divisional funds of \$12,334 or 18.1% will be committed to new projects or project extensions by the time of the Torino GA.

In addition to the biennial Divisional budget, active projects have attracted \$6,000 of supplemental funding from the IUPAC Project Committee and \$21,800 of matching funds from external organizations during 2006 and 2007. Finally, book royalties of \$2,264 have been granted to the Division for new project development by John Wiley and Sons based on the ongoing book contract.

4. FUTURE OPPORTUNITIES AND DIRECTION

To remain effective and maintain relevance, the Division will need to pay attention to both current strengths and weaknesses of the IUPAC approach, and seek a way forward that takes advantage of the opportunities while avoiding looming threats. The Division Committee recently took the first steps toward development of a long-range Division activities plan in alignment with the IUPAC long-range goals. Key future areas of interest for the Division in its operations are listed briefly below, and these are expected to be the subject of intense discussions during the Torino GA.

- Maintenance of a diverse membership and participation for Divisional activities – The membership (24) of the DC for the current biennium includes representatives of 20 countries, with each region of the globe well represented with the exception of Latin America. The DC includes 5 women and 2 representatives from scientifically emerging countries. It will be important for the health of the Division to continue to maintain diversity of representation for areas of disciplinary emphasis, affiliation, geographic origin,

age, and gender. This need for diversity also applies to the activities of Division-sponsored sub-committees and project task groups. There is in particular a need to increase participation in Divisional programs from Latin American, Middle Eastern, and African nations. There is also a tendency for an under-representation of IUPAC contributors from the industrial sector, and greater efforts are needed to ensure adequate participation of industry chemists.

- Continued generation of project proposals – A continued flow of high quality project proposals is critical to the future effective contributions of the Division. Although a number of new proposals have been received during the current biennium for consideration, the overall rate of submission of new proposals has been decreasing during each of the past several years. In addition, although conference proposals come from many quarters, project proposals primarily originate from those with some familiarity with IUPAC. Today's chemists face many choices for project involvement at the national and regional levels. The Division needs to find creative ways to continue to identify relevant new project topics and solicit proposals from interested and enthusiastic chemists willing to lead and serve on IUPAC task groups.
- Timely completion of ongoing projects – More than 20 active projects are now supported by the Division, and the Division collects regular progress reports so as to allow monitoring of project progress. It is important that IUPAC projects are completed within a reasonable time so as to produce relevant and useful findings. Decisions to accelerate (e.g., top-up funding) or abandon several of the older, slower-moving projects will be needed in near future.
- Continued ramp-up of food chemistry activities – Following an idea-generating workshop at the Beijing GA, food chemistry activities are slowly increasing following a lull of several years. Two active projects on food chemistry are now supported and a third proposal is anticipated to be approved in near future. Identifying a new leader for the Food Chemistry Sub-Committee will be an important step in solidifying an active future program.

APPENDIX I. EXISTING PROJECTS (active as of January 2006)

- 630/24/95 - Solute movement in soils with potential rapid by-pass transport (completed and report in-press)
- 1999-041-1-600 - Bioavailability of xenobiotics in the soil environment (nearing completion)
- 1999-014-2-600 – Airborne and remote monitoring of water quality: evaluation of remote sensing techniques for water quality control in surface water bodies (abandoned based on lack of progress)
- 2001-022-1-600 - Global availability of information on agrochemicals (ongoing – extension under consideration)
- 2001-023-1-600 - Agrochemical spray drift: Assessment and mitigation (nearing completion)
- 2001-024-2-600 - Impact of transgenic crops on the use of agrochemicals and the environment (completed and report in-press)
- 2001-026-1-600 - Use of reference soils for testing fate and effects of chemicals (ongoing)
- 2001-039-1-600 - Pest management for small-acreage crops: a cooperative global approach (nearing completion)
- 2002-013-2-600 - Determination of trace elements in oils and fats by inductively coupled plasma optical emission spectroscopy - evaluation of a method by collaborative study (nearing completion)
- 2003-011-3-600 - A critical compendium of pesticide physical chemistry data* (ongoing)
- 2003-013-1-600 - Crop protection chemistry in Latin America: Harmonized approaches for environmental assessment and regulation (ongoing)
- 2003-014-2-600 - Fractal structures and processes in the environment (completed and report in-press)
- 2003-017-2-600 - Remediation technologies for the removal of arsenic from water and wastewater (completed and report in-press)
- 2003-030-1-600 - Glossary of atmospheric chemistry (to be abandoned based on lack of progress)
- 2003-058-1-600 - Air pollution models in environmental management and assessment (ongoing)
- 2004-002-1-600 - Glossary of terms related to pesticides (completed and report published)
- 2004-003-3-600 - Biophysico-chemical processes of heavy metals and metalloids in soil environments (completed and report in-press)
- 2004-005-2-500 - Comparable pH measurements by metrological traceability* (ongoing)
- 2004-011-1-600 - Development of simplified methods and tools for ecological risk assessment of pesticides (ongoing – extension under consideration)

2004-015-1-600 - Environmental colloids: behavior, structure and characterization (completed and report published)

2004-017-1-500 - Standardization of analytical approaches and analytical capacity-building in Africa* (ongoing)

2004-022-3-400 - Terminology and measurement techniques of starch components* (ongoing)

* Interdivisional project

APPENDIX II: NEW AND PROPOSED PROJECTS (since January 2006)

- 2005-024-2-600 - Establishment of guidelines for the validation of qualitative and semi-quantitative (screening) methods by collaborative trial: a harmonized protocol* (continued as 2006-027-1-600)
- 2005-042-1-300 - Chemistry for Biology - an inventory for interdivisional and interdisciplinary activities within IUPAC in the field of biological chemistry*
- 2005-048-2-100 - Solubility and thermodynamic properties related to environmental issues*
- 2006-011-1-600 - Critical review of available methods to predict VOC emission potentials for pesticide formulations
- 2006-014-1-600 - Biophysico-chemical processes involving natural nonliving organic matter in environmental systems
- 2006-015-3-600 - Evaluation of food and feed safety implications of (altered) residues of pesticides applied on transgenic (GM) crops
- 2006-017-2-600 - Crop protection chemistry in Asia: harmonized approaches for safety evaluation, regulation, and protection of trade
- 2006-039-1 - Extraction and fractionation methods for risk assessment related to trace metals, metalloids and hazardous organic compounds in terrestrial environments*
- 2006-044-2-600 - Environmental risk assessments for the registration of pesticides used in rice paddy fields
- 2006-049-2-600 - Combination of chemical analytical measurements and remote sensing techniques for coastal water monitoring. The cases of Eastern Mediterranean and Black Sea
- 2007-015-1-000 - *Future energy: sustainable and clean energy alternatives for our planet**
- 2007-017-1-000 – *What are dietary fibres?**

* Interdivisional project *or proposed interdivisional project*

APPENDIX III. RECENT AND PENDING PUBLICATIONS

Technical Reports and Recommendations

Garelick, H. "Remediation technologies for the removal of arsenic from water and wastewater." *Rev. Environ. Contam. Toxicol.* (2007) *in press*.

Kleter, G.A.; Bhula, R.; Bodnaruk, K.; Carazo, E.; Felsot, A.S.; Harris, C.A.; Katayama, A.; Kuiper, H.; Racke, K.D.; Rubin, B.; Shevah, Y.; Stephenson, G.R.; Tanaka, J.; Unsworth, J.; Wauchope, D.; Wong, S.S. "Altered pesticide use on transgenic crops and the associated general impact from an environmental perspective." *Pest Manag. Sci.* (2007) *in press*.

Kördel, W.; Egli, H.; Klein, M.; "Transport of pesticides via macropores." *Pure Appl. Chem.* (2007), *in-press*.

Stephenson, G.R.; Ferris, I.G.; Holland, P.T.; Nordberg, M. "Glossary of terms relating to pesticides." *Pure Appl. Chem.* (2006), 78:2075-2154.

Books

Ohkawa, H.; Miyagawa, H.; Lee, P.W. *Pesticide Chemistry: Crop Protection, Public Health, Environmental Safety.* Wiley-VCH, Berlin (2007) *in press*.

Senesi, N. *Biophysical Chemistry of Fractal Structures and Processes in the Environment.* John Wiley and Sons, New York (2007) *in press*.

Stephenson, G.; Solomon, K.; Carazo, E. *Pesticides in the Environment.* University of Costa Rica Press, San Jose (2007) *in press*.

Violante, A.; Huang, P.M.; Gadd, G.M. *Biophysico-Chemical Processes of Metals and Metalloids in Soil Environments.* John Wiley and Sons, New York (2007) *in press*.

Wilkinson, K.; Lead, J. *Environmental Colloids and Particles: Behavior, Separation, and Characterization.* John Wiley and Sons, New York (2007) 672 pages.

Other Reports

Kördel, W.; Klein, M. "Prediction of leaching and groundwater contamination by pesticides." *Pure Appl. Chem.* (2006) 78:1081-1090.

Loffredo, E.; Senesi, N. "Fate of anthropogenic organic pollutants in soils with emphasis on adsorption/desorption processes of endocrine disruptor compounds." *Pure. Appl. Chem.* (2006), 78: 947-961.

Racke, K.D. "Pesticide chemistry - report of the 11th IUPAC international congress." *Chem. Int.* (2007) 29: 30-32.