



International Union of Pure and Applied Chemistry

A member of the International Council of Scientific Unions

Division VI, Chemistry and the Environment

Report to Bureau, May 2019

Submitted by Rai S Kookana, President

I. Highlights and Executive Summary

Through world-recognized expertise and experience via its members and project teams, Division VI (Chemistry and the Environment) - makes scientifically sound and timely contributions towards addressing the critical environmental issues at a global scale. We provide authoritative reviews and guidance on the fate, behavior and risks of chemical compounds in food and the environment by undertaking both fundamental and applied project activities to solve pressing environmental problems and enhance quality of life.

Our salient achievements/activities are listed below.

Expertise, Diversity and Inclusiveness

- We are undergone a significant renewal in this biennium. Our team now represents 20 nations and reflects gender balance (60% females), diversity and inclusiveness. In terms of diversity of skills, our expertise in chemistry and the environment spans across a range of disciplines, essential for solving complex problems. In May 2018, we held our Divisional committee meeting in Rome, in combination with the SETAC conference where the Division organized a session and presented several project related talks.

Project portfolio and leadership

- In pursuit of greater collaboration with other Divisions (e.g. Div. III, V and VII) and Committees (e.g. COCI, CCE), we have commenced a number of joint projects (see section III and IV), often co-financed by the participating divisions. These projects are delivered via two subcommittees: (i) *The Sub-committee on Crop Protection Chemistry* and (ii) *The Sub-committee on Chemical and Biophysical Processes in the Environment* (section III).
- Our projects have brought together industry, regulatory agencies, academia and researchers and provided global leadership on complex science issues (e.g. Nanomaterials/Nanopesticides, e-waste, risk assessment– section III & IV).
- IUPAC leadership on Nanopesticides project has been recognized by top-ranking journal Nature, and the IUPAC task group leader was invited by Nature Nanotechnology to contribute to a review, now published (Section IV).
- Our project pipeline is healthy and strong, with several new projects that have commenced. Several overdue projects have been completed during last year.
- We have made a succession planning for our leadership. Two project coordinators have been appointed. Division rules have been revised.

Global outreach, technology transfer and collaborations

- A special symposium (three sessions) has been organized for the Chemistry for the Environment theme at the 47th IUPAC Chemistry World Congress in Paris.
- We made a major contribution to the organization of 14th IUPAC International Congress of Crop Protection Chemistry soon to be held in Ghent, Belgium (May 19th - 24th 2019).

- A highly successful symposium on the “Improvements in Environmental Exposure Assessment” was held with SETAC Europe in Rome during 22-26 May, 2018.
- We recognized outstanding contributions to international harmonization for the regulation of crop protection chemistry by the late Mark Lynch of Eire through an award to be given in 2019 at the IUPAC Pesticide Congress in Ghent.
- The Division will be organizing a three-sessions symposium under theme “Chemistry and the Environment: Symp. 3.5”- Innovative Chemistry for Environmental Enhancement.
- *The IUPAC 100 celebrations:* We are making significant contributions to IUPAC100 through committee co-chair, Laura McConnell. Several promotional activities were conducted by members of our committee, e.g. in India by Dr Saha.

II. Plans and priorities for this biennium, and beyond

Overall strategy of the Division and alignment with IUPAC plan:

We have consolidated our project portfolio in keeping with the main thrust of Division’s strategy and leveraging on the unique leadership opportunities these may offer to IUPAC. Broadly, we will continue to provide authoritative reviews and guidance on the fate, behavior and risks of chemical compounds in the environment to solve pressing environmental problems. We will continue to be selective and focused in our approach. Recognizing the multidisciplinary nature of the divisional projects, we will continue to harness collective interdivisional capability and expertise of IUPAC which to some extent make IUPAC unique. We have a strong track records of cooperation/ collaboration with large and successful organizations such as ACS and SETAC and we will continue to foster these. We will ensure timely reporting and delivery on current projects. We have been successful in infusing new blood to the divisional committee, activities and leadership. We will continue our double our efforts in this regard.

Summary of the number and general types of projects

To provide scientifically sound and timely contributions towards addressing the critical environmental issues at a global scale is our main goal. In collaboration with other Divisions (e.g. Div. III, V and VII) and Committees (e.g. COCI, CCE), we currently have 17 active projects (see full list and their status in section IV). Through these we are currently covering a range of chemistry and environment related topics (ranging from e-waste to nanomaterials, from metals to pesticides toxicants, from risk assessment to regulations) underpinned by fundamental understanding of biogeochemical processes governing the fate and behavior of chemicals in the environment as well as their exposure and risk assessment. In some of these the IUPAC leadership has been well recognized, as discussed in section III of this report.

While we have a strong track-record of multidisciplinary inter-divisional projects, we plan to have at least 60% of our projects that are inter-divisional in nature by 2020. This is (i) to harness the collective capability of IUPAC, (ii) to provide more comprehensive solutions to the problem, (iii) to gain better recognition internationally and (iv) to achieve greater congruity in IUPAC activities as well as to offer stronger financial base to the projects.

Currently we have 8 inter-divisional projects, some of which are jointly co-chaired and equally financed (e.g. 2017-035-2-600).

III. An overall report of Division/Committee activities and achievements during 2018-2019

Goal: Provide scientific expertise to address critical needs on Chemistry and the Environment

We integrate, synthesize and deliver these projects via two subcommittees, namely (i) *The Advisory Committee on Crop Protection Chemistry*, and (ii) *The Advisory Committee on Chemical and Biophysical Processes in the Environment*. Some of the activities of committees and projects under both of these subcommittees are listed as examples of achievements towards the above strategic goal of IUPAC.

(i) The Sub-committee on Crop Protection Chemistry

The Committee provides unbiased and authoritative views regarding environmental and human health aspects of crop protection chemistry. Through its timely projects, publications, and outreach activities the Committee seeks to advance research understanding and promote environmental stewardship.

The Advisory Committee on Crop Protection Chemistry has evolved from various IUPAC Commissions prior to the adoption of the project system: since 2002 the committee has been called the Advisory Committee on Crop Protection Chemistry. Minutes of meetings of the various bodies are available in pdf format from 1983 to the present.

The Committee is currently comprised of 28 members, from 14 different countries, representing both developed and scientifically emerging countries: Argentina, Australia, Brazil, Canada, China, Colombia, Costa Rica, Greece, Japan, The Netherlands, South Korea, United Kingdom, United States and Uruguay. Members are drawn from government, academia, industry and private consultancies, thus ensuring a wide spread of expertise and experience.

There is significant interest in the Committee and a category of "Affiliate Membership" has been set up. This consists of scientists that are interested in the work of the Committee and wish to be kept up to date on its current activities. There are currently 21 affiliate members from 16 countries: Australia, China, Germany, Greece, India, Israel, Kenya, Pakistan, Poland, Russia, South Africa, South Korea, Taiwan, Uganda, United Kingdom and the United States.

The Committee tries to meet formally in association with an IUPAC-sponsored Congress or regional workshop. The next full meeting of the Committee will be held in Ghent, Belgium during the 14th IUPAC International Congress of Crop Protection Chemistry (May 19-24, 2019).

(ii) The Sub-committee on Chemical and Biophysical Processes in the Environment:

The Subcommittee on Chemical and Biophysical Processes in the Environment of the IUPAC Division of Chemistry and the Environment (Division VI) was established in 2014. It combines the activities of the previously existing division subcommittees on Biophysico-Chemical Processes in Environmental Systems and on Chemistry of Environmental Compartments.

The subcommittee deals with topics regarding the distribution and environmental fate of chemicals (inorganic and organic compounds, nanomaterials), chemical and biophysical processes in environmental compartments (e.g., in soil and aquatic ecosystems) and interactions with organisms (bioavailability).

Currently about 25 scientists from around 15 countries are collaborating in the subcommittee. Many of the subcommittee members are involved in currently running IUPAC projects. Such projects cover topics like [metal bioavailability in aquatic systems](#), the [potential environmental risks of e-waste](#), or [trace elements analysis of environmental samples with X-rays](#).

Although many of the members of the Subcommittee on Chemical and Biophysical Processes in the Environment are elected members of the IUPAC Division of Chemistry and the Environment (Division VI), the subcommittee is open to all scientists which are interested in questions regarding the topics of the subcommittee. Interested persons may contact the subcommittee chairs in order to get information and apply for membership.

Main outcomes from IUPAC projects managed via this committee are review papers, technical reports or books on certain topics. Recent examples are a [book on the biophysico-chemical processes and toxicity of engineered nanoparticles](#), a [review paper on the consideration of bioavailability for the risk assessment of metal species in waters](#), or a [guidance paper on substance-related environmental monitoring strategies regarding soils and waters](#). Subcommittee members also try to identify new project ideas and develop new project proposals.

Some project activities managed through the two sub-committees demonstrating the outputs and outcomes associated with the core objectives above are listed below.

Highlights from current projects of both Committees

Project Name (No.)	Leader	Status
Development of a technical symposium on 'Innovative chemistry for environmental enhancement' for Theme 3 'Chemistry for the environment' at the 47th IUPAC World Chemistry Congress, Paris, 2019 2018-026-2-600	Purchase	Division VI is organising a special symposium divided in three sessions for the Chemistry for the Environment theme in the 47th Chemistry World Congress in IUPAC Paris 2019. The aim of the symposium is to highlight the role of chemistry in providing innovative solutions to meet environmental challenges as well as enhance the environment. Excellent keynote and invited speakers around the world for all three sessions have been secured.
Guidance for Industry and Regulators on Assessment of the Environmental Fate and Risks of Nano-enabled Pesticides 2016-016-2-600	Kookana	The project brought together stakeholders from regulatory agencies, academia, research and the agrochemicals industry to seek their perspectives on relevant considerations pertaining to the problem formulation phase of the ecological risk assessment of nano-enabled pesticides. "A perspective on problem formulation" has been developed and published by Journal of Agricultural and Food Chemistry, 2018, 66, 6480-6486. IUPAC leadership on this important topic was recognised by Nature publishing house and the task group leader was invited to contribute to an overview article in Nature Nanotechnology (Volume 13, 677–684). Nanopesticides has also been chosen by IUPAC team in top ten technologies that have the potential to change the world and an article on these is in press.
Advances on the Assessment of Pesticides' Soil Microbial toxicity: New research and regulatory aspects in light of the recent methodological advances 2014-032-1-600	Karpouzas	The conclusions drawn from this project and a proposal for the regulatory framework regarding the assessment of the soil microbial ecotoxicity of pesticides will be summarized in a paper which will be published in a relevant journal as open access to increase visibility. Data are expected to be presented in the 14th IUPAC International Congress of Pesticide Chemistry in Ghent, May 2019.
Inventory of developments in the field of RNAi-based pesticides and potential needs for international harmonization of	Kleter	Presentation on human and animal safety considerations of RNAi technology, both for GM-plant-incorporated dsRNA and dsRNA used as pesticide active ingredient, during the iPlanta conference on RNAi plant applications in Poznan, Poland, on February 15th, 2018, which also highlighted the

regulatory safety requirements 2013-029-2-600		IUPAC project, among others (http://iplanta2018.home.amu.edu.pl/) Collection of articles and data on RNAi by team members ongoing. Continuation of preparation of a review manuscript highlighting regulatory and safety considerations, based on textual inputs already received from various team members, to be collated and finalized in 2019.
The Importance of Chemistry in Maintaining a Secure Food Supply 2012-019-1-600	Unsworth	A Chapter has been prepared for publication in a book entitled "Sustainable Agrochemistry: A Compendium of Technologies" to be published by Springer
Consideration of bioavailability of metals/metal compounds in the aquatic environment 2011-060-1-600	Rüdel	The project has provided information on metal and metalloid bioavailability and the application of Biotic Ligand Model and bioavailability-based software tools for freshwater risk assessment. A first outcome of the project is a review on the current state of the application of bioavailability-based approaches in risk assessment approaches. The findings from this project is being disseminated via a website http://www.metal-bioavailability.org/ on the bioavailability of metals. Similar websites for other projects (e.g. on e-waste) is currently under development. Findings from this project have been presented in the special IUPAC symposium during the SETAC 2018 conference in Rome.
Trace Elements Analysis of Environmental Samples with X-Rays: From Synchrotron to Lab and from Lab to Synchrotron 2016-019-2-600	Terzano	A one-day special Symposium entitled "TRACE ELEMENTS ANALYSIS OF ENVIRONMENTAL SAMPLES WITH X-RAYS" was organized during the ICOBTE 2017 Conference, which took place in Zurich (Switzerland) from 16 to 20 July 2017. An IUPAC Technical Report has been submitted to Pure & Applied Chemistry in July 2018 and has been accepted for publication on March 13 th , 2019.
Environmental and health challenges of e-waste and its management: an emerging 21 st century global concern 2014-031-3-600	Purchase	A manuscript entitled "A critical review on the chemical properties and ecological impacts of e-wastes" is in the final stage of preparation for submission to <i>Pure And Applied Chemistry</i> . This will be the first of the series of review papers to be published by the project.

Goal: Capability development and technology transfer:

We have organized several high profile outreach/ tech-transfer activities during 2018-2019, e.g.

- We conducted a successful IUPAC session in May 2018 in Rome in collaboration with SETAC-EU on, “**Improvements in Environmental Exposure Assessment: Development and Application of Tools across Industry Sectors, Regulatory Agencies, and International Boundaries**”. A total of 12 oral presentations and 34 poster presentations were included in the session, including several IUPAC projects.
- To promote sustainable application of nanotechnology in Agriculture, a workshop on “**Human Health Considerations of Nanopesticides**” was held in Boston from 8-9th June, jointly funded by Division VII and VI (project number 2017-035-2-600).
- We have organized a Symposium at the 47th Chemistry World Congress in IUPAC Paris 2019.
 - Session on **Innovative Chemistry in Industrial Solutions** - Chemistry for the Environment theme in the 47th Chemistry World Congress in IUPAC Paris 2019 (<https://www.iupac2019.org/chemistry-for-the-environment>).
 - Session on **Advanced Techniques for Pollution and Waste Reduction** - Chemistry for the Environment theme in the 47th Chemistry World Congress in IUPAC Paris 2019 (<https://www.iupac2019.org/chemistry-for-the-environment>).
 - Session on **Novel Approaches to Tackle Global Environmental Challenges** - Chemistry for the Environment theme in the 47th Chemistry World Congress in IUPAC Paris 2019 (<https://www.iupac2019.org/chemistry-for-the-environment>).
- **14th IUPAC International Congress of Pesticide Chemistry** will take place in Ghent, Belgium, May 19th - 24th, 2019. (www.iupac2019.be)
 - **Advances in Harmonized Approaches to Crop Protection Chemistry** This award recognizes individuals in government, intergovernmental organizations, industry, and academia who have exercised personal leadership for outstanding contributions to international harmonization for the regulation of crop protection chemistry. The awardee for 2019 is the late Mark Lynch of Eire and the award will be given in 2019 at the 14th IUPAC Pesticide Congress in Ghent
- **15th IUPAC International Congress of Pesticide Chemistry** – following a “Call for Proposals” this conference is now scheduled for New Delhi, India in 2023.
- The proposed **4th International Conference on Agrochemicals Protecting Crops, Health and Natural Environment –“Discovery and Development of Synthetic and Natural Products for Pest Management”** has been provisionally scheduled for January 2020 in New Delhi, India.

IV. Tabular material.

Selected publications (2017-2019)

1. Terzano, R., Denecke, M.A., Falkenberg, G., Miller, B., Paterson, D., Janssens, K. (2019) "Recent advances in analysis of trace elements in environmental samples by X-ray based techniques", *Journal of Pure & Applied Chemistry* (in press) accepted on 13th March 2019.
2. Saha, B. B., Reddy, N., Chandra, J. (2019). 150th Anniversary of Periodic Table and Mendeleev, *Chemical News (India)*, XIX, (2), 26-29.
3. Reddy, N., Chandra, J. Saha, B. (2019). Mendeleev and the Periodic Table, *Chemical Industry Digest Annual (India)*, 32, (1), 84-87.
4. Kah, M., Kookana, R.S., Gogos, A., Bucheli, T.D. (2018). A critical evaluation of nanopesticides and nanofertilizers against their conventional analogues. *Nature Nanotechnology*, 13, 677–684. (<https://doi.org/10.1038/s41565-018-0131-1>).
5. Walker, G.W., Kookana, R.S., Smith, N.E., Kah, M., Doolette, C.L., Reeves, P.T., Lovell, W., Anderson, D.J., Turney, T.W., Navarro D.A. (2018). Ecological Risk Assessment of Nano-enabled Pesticides: A Perspective on Problem Formulation. *Journal of Agricultural and Food Chemistry*, 66, 6480-6486.
6. Purchase, D., Obare, S., Unsworth, J., & Garellick, H. (2018). Chemistry and the Environment. *Chemistry International*, 40(2), 46–51.
7. Chan, W.K, Wildeboer, D., Garellick, H., Purchase, D. (2018) Competition of As and other Group 15 elements for surface binding sites of an extremophilic Acidomyces acidophilus isolated from a historical tin mining site. *Extremophiles*, 22 (5). pp. 795-809. ISSN 1431-0651
8. Pantoja Munoz, L., Gonzalez Baez, A., McKinney, D., Garellick, H. (2018) Characterisation of “flushable” and “non-flushable” commercial wet wipes using microRaman, FTIR spectroscopy and fluorescence microscopy: to flush or not to flush. *Environmental Science and Pollution Research*, 25 (20). pp. 20268-20279. ISSN 0944-1344.
9. Purchase, D., Bisschop, L., Ekberg, C., Fedotov, P., Garellick, H., Kandile, NG., Luque, R., Popoola, O., Rüdel, H., Serpe, A., Surati, K., Wilson, BP., (2018). Global approaches to environmental exposure-assessment of e-wastes. *Proceedings SETAC Europe 28th Annual Meeting*, Rome, Italy, 13-17 May 2018.
10. Shevah, Y. (2018). Middle East regional cooperation and sustainable water management of transboundary water. (2018). *Chemistry International*, 40(2), 35–38.
11. Isimekhai, K., Garellick, H., Watt, J., Purchase, D. (2017) Heavy metals distribution and risk assessment in soil from an informal e-waste recycling site in Lagos State, Nigeria. *Environmental Science and Pollution Research*, 24 (20). pp. 17206-17219. ISSN 0944-1344
12. Unsworth JB and Carazo E. (2017). Ecological Risk Assessment. *Chemistry International* 39 (4) 45-46.
13. Saha BB. (2017). IUPAC 2017- World Chemistry Congress and IUPAC general Assembly. *Chemistry International* 39 (4) 46-49.
14. Perminova IV. (2017). Database on molecular compositions of natural organic matter and humic substances as measured by high resolution mass spectrometry. *Chemistry International*. 39 (2) 21-21. [DOI 10.1515/ci-2017-0213](https://doi.org/10.1515/ci-2017-0213).
15. Kookana RS (2017). Environmental Fate and Risks of Nano-enabled Pesticides. *Chemistry International*. *Chemistry International* 39 (1) 24-25.

16. McConnell LL, Racke KD, Hapeman KJ, Seiber, JN. (2017). 13th IUPAC International Congress of Pesticide Chemistry: Crop, Environment, and Public Health Protection, Technologies for a Changing World. *J. Agric. Food Chem.*, 64 (1), 4-5.
17. Berenbaum MR. (2017). Does the Honey Bee "Risk Cup" Runneth Over? Estimating Aggregate Exposures for Assessing Pesticide Risks to Honey Bees in Agroecosystems. *J. Agric. Food Chem.*, 64 (1), 13-20.
18. Ambrus, A. (2017). International Harmonization of Food Safety Assessment of Pesticide Residues. *J. Agric. Food Chem.*, 64 (1), 21-29.
19. Ambrus, A. and Yang YZ. (2017). Global Harmonization of Maximum Residue Limits for Pesticides. *J. Agric. Food Chem.*, 64 (1), 21-29.
20. Venkat Reddy, S and Saha, B. (2017). Green Chemistry for Sustainable Development, *Chemical Industry Digest*, 30(6), 82-87.

List of current projects

Project Number	Task Chair	Title	Status
2011-023-2-600	Harris	Critical review of approaches to dietary risk assessment for pesticides	On-going
2012-019-1-600	Unsworth	The Importance of Chemistry in Maintaining a Secure Food Supply	On-going
2013-024-2-600	Molyneux	Recommended Methods for the Structural Identification of Biologically Active Compounds in Food and Flavor Chemistry	On-going
2013-029-2-600	Kleter	Inventory of developments in the field of RNAi-based pesticides and potential needs for international harmonization of regulatory safety requirements	On-going
2014-026-3-600	Obare	Chemical speciation of anthropogenic nanoparticles. Environmental Chemistry - Development of Three Technical Symposia at the 46th IUPAC Congress, São Paulo 2017	On-going
2014-031-3-600	Purchase	Environmental and health challenges of e-waste and its management: an emerging 21 st century global concern	On-going
2014-032-1-600	Karpouzas	Advances on the Assessment of Pesticides' Soil Microbial toxicity: New research and regulatory aspects in light of the recent methodological advances	On-going

2015-010-3-600	Keen	Standardization of electrical energy per order (EEO) reporting for UV/H ₂ O ₂ reactors	On-going
2015-056-3-600	Kalderis	Glossary of terms used in biochar research	On-going
2016-015-2-600	Perminova	Database on molecular compositions of natural organic matter and humic substances as measured by high resolution mass spectrometry	On-going
2016-016-2-600	Kookana	Guidance for Industry and Regulators on Assessment of the Environmental Fate and Risks of Nano-enabled Pesticides	On-going
2016-019-2-600	Terzano	Trace elements analysis of environmental samples with X-rays: from synchrotron to lab and from lab to synchrotron	On-going
2016-047-1-600	Xing	Multi-scale Biogeochemical Processes in Soil Ecosystems: Critical Reactions and Resilience to Climate Changes	On-going
2017-013-1-600	Racke	Crop protection chemistry in Latin America: Harmonized approaches for environmental assessment and regulation	On-going
2017-035-2-600	Kookana	Human Health Risk Consideration of Nano-enabled Pesticides for Industry and Regulators	On-going
2018-013-2-600	Shevah	Bioavailability of endocrine substances in aquatic ecosystems	On-going
2018-026-2-600	Purchase	Development of a technical symposium on 'Innovative Chemistry for Environmental Enhancement' for Theme 3 'Chemistry for the Environment' at the 47th IUPAC World Chemistry Congress, Paris, 2019	On-going
2018-039-3-600	Sakellariadou	Seabed mining and blue growth: Exploring the potential of the marine mineral deposits as a sustainable source of rare earth elements (MAREE)	On-going