

# The Role of Ecological Chemistry in Pollution Research and Sustainable Development

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**Series C: Environmental Security**

# The Role of Ecological Chemistry in Pollution Research and Sustainable Development

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# PREFACE

Sustainable Development has become the leading concept of the 21 century. It describes a development, which agrees with the needs of the present generation but does not endanger the chances of the coming generations to satisfy also their needs. “Sustainable development” has become an important general goal for all fields of life like economy, ecology and social balance. The development and shaping of our future has been discussed internationally like on the summits of the Conferences in Rio and in Johannesburg. But this is also a topic on national base in various countries. Leading authorities in various fields of economy and politics have also accepted this concept.

Although the concept of sustainable development has been generally accepted, there are still problems how to achieve and evaluate these general goals. It is clear that the definitions about the prime needs vary from man to man, from country to country and from continent to continent. **But pollution does not respect national borders.** Therefore, it is necessary to develop the politics of economy, ecology and social demands by a synergistic way that they are strengthened by each other. If it is not possible to stop tendencies, which threaten the future quality of life, the cost demands of societies will dramatically increase and negative tendencies will become irreversible.

The European policy agrees to go a common way of sustainable development and to establish the general conditions for this. The coming years will show how well the defined model can be realized. This is the main task for politics. But other subjects like NGOs, associations of research institutions and the industry as well as organizations for the protection of nature play also an important part to develop the model of sustainable development.

The Commission of the German Parliament proposed the following ecological rules for a sustainable development:

- The rate of the use of renewable resources should not exceed the rate of their regeneration. This corresponds to demanding the sustainability of ecological performance, i.e., (at least) a sustainability of an ecological capital defined by its functions.
- Emissions to the environment should not exceed the capacity of individual ecosystems.
- The timeframe of anthropogenic impacts on the environment must be in a balance to the timeframe of the reaction ability of relevant natural processes in the environment.
- Dangers and risks for human health resulting from anthropogenic activities must be minimized.

Research and innovation are preconditions for the transformation of economic and social processes in favor of a sustainable development. Chemistry, the science and practice of the transformation of matter, is of central importance thereby.

NATO Advanced Research Workshop on *The Role of Ecological Chemistry in Pollution Research and Sustainable Development* aimed to bring together scientists from different fields of Ecological Chemistry and Sustainability from Eastern, Western and Southern Countries in order to present their recent research findings and to exchange ideas how to overcome the problems of environmental pollution and how to move towards a sustainable new world. This workshop was co-organized by Braunschweig University of Technology from Germany and the Academy of Sciences of Moldova, being supported by NATO Science for Peace and Security Programme. Thirty-four prominent scientists and specialists in Ecological Chemistry from thirteen countries contributed with oral and poster presentations.

The workshop was the continuation of a series of international events on Ecological Chemistry held in Chisinau, Moldova in 1995, 2002 and 2005. During the last International Conference in 2005, it was concluded to strengthen the interactions between the scientists in the field of environmental chemistry from Western and Eastern Europe, USA, Arab and NIS Countries to promote the exchange of the latest experience and closer involvement of scientists in international cooperation. The event was proposed to be held in Moldova in order to involve as many scientists as possible from the NIS countries and hence to strengthen the links from both parts of the political world.

The objective of this NATO Advanced Research Workshop was to present examples of the state-of-the-art of pollution research in the NIS, Middle East and Western European Countries on Soil and Water Pollution and then to discuss on promising approaches and strategies for environmentally friendly technologies towards a sustainable development incl. capacity building by education. It was aimed.

- To review a set of ecological chemistry issues from pollution research to sustainable development relevant to regional and international cooperation.
- To explore ways of strengthening the role of researchers in environmentally friendly policies and decision making in the national and regional contexts.
- To enhance the role of ecological chemistry in society and the building of knowledge societies based on a peaceful development in Western and Eastern Europe, USA, Arab and NIS countries.

As responsible co-directors of this workshop and editors of this book we hope that the scientific contributions and outcomes of intensive discussions attach great importance to this event.

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## Scientific Content

The NATO ARW Meeting entitled **The Role of Ecological Chemistry in Pollution Research and Sustainable Development** was scheduled in **six sessions** dealing with **(1) Organic Pollutants and POPs in the Environment, (2) Water Pollution and Wastewater Treatment, (3) Soil Pollution and Prevention, (4) Waste Management, (5) Risk Assessment, Mitigation Measures and Environmental Awareness, and (6) General Discussion, Conclusions and Recommendations.**

In the **Session 1**, an overview of **POPs Management in Moldova, Ukraine and Turkey** was given as an example. All these three countries already approved the POPs convention of Stockholm and are presently making efforts to take an inventory and to manage the POPs stockpiles. In each case they established POPs teams which are working on this subject. Besides POPs, they are also working on the problem of obsolete pesticides which are partly listed up within the POPs. The overall goals include developing a National Implementation Plan NIP, to inform and make aware public and the stakeholders for participation, and to work on legal frameworks which are in agreement with the EU directives. Besides this planning work, POPs have to be registered, the stockpiled substances partly repacked in suitable containers, and transported to destruction facilities. What is lacking of is the partly non-availability of sufficient capacities of such plants for POPs destruction in these countries likely resulting in the problems of trans-boundary transportation of hazardous wastes across Europe. Further topics in this session dealt with the problems of **brominated flame retardants** and their solution, **pharmaceuticals and personal care products** and their behaviour in wastewater treatment plants, and occurrence of **chlorinated dioxins and furans in Venice Lagoon.**

The **Session 2** gave first an **Overview of Water Research and Management** exemplified at the case of Moldova and continued with two sets of presentations showing the main aspects in water research: (i) **Fundamental Research** on Phys.-Chem. Processes occurring in natural and technological waters and study of the reaction mechanisms and intermediate products, and (ii) the **Applied Aspects** of Wastewater and Sludge Treatment and Reuse, with the recovery of specific elements from it. As a conclusion, one may note that many key fundamental and applied issues of water pollution and wastewater treatment were discussed at the workshop. The presentations and discussions have demonstrated that the scientists have in general a close approach in studying and explaining the natural processes in waters, and elaboration and application of water treatment, supply and reuse. The presentations have elucidated the various sides of the same paramount problem, which is faced by the mankind nowadays – research of the phenomena occurring in natural and wastewaters, with the scope to provide the sustainable management of waters and protect the water resources. Only such approach would enable to develop and implement the model of sustainable development that has no alternative. Although the presentations contained the information, experience and data directly related to the original research and problems in the specific

countries, however, their importance cannot be limited only by these respective countries. In a broader sense, the results presented can be used by the research community and water systems managers worldwide.

The presentations in the **Session 3** can be concluded as follows: Soil pollution and degradation brought about by chemicals for plant protection, irrigation water with an increased degree of mineral content, oil products, exhaust gases, industrial wastes, organic wastes from animal manures, and humus losses by soil erosion. In order to preserve the soil fertility erosion should be prevented; optimal doses of organic fertilizers, compost or natural organic matters should be applied. Natural organic matter, especially humic substances exert important protective effects in soils for plants, surface and ground waters. The use of organic amendments in soil will not only has positive effects on soil fertility and agricultural production, but also contributes to protect soil and related environment from organic pollution. Soil amendment polymers like hydrogels also improve soil fertility especially in degraded soil in semi-arid climates and desert areas. Veterinary medicinal products VMP and biocides for disinfection in stables enter manure and following the agricultural soils depending on the persistence of these substances. Development of Technical Guidance for laboratory testing on degradation of VMP and biocides in manures and degradation and sorption in soils thus may sustainably contribute to more sophisticated prediction the fate of these bioactive substances before application.

**Session 4** dealt with the **overall** as well as **particular aspects of waste management**. According to the existing management scheme, the wastes produced in the households are collected commingled and transported to landfills or dumping places by the municipalities. These need to be improved in most countries. Investigations are performed in order to re-structure the waste management in legal and technological aspects, according to the rules of sustainable waste management. Wastes contain hazardous constituents but can also be considered as a valuable resource for recycling. It is possible to gain money and save significant amount of resources by implementing the right collection, recycling, and treatment options and technologies. In low income country the first step of a suitable waste management is separation at source. The produced waste can be separated into wet and dry fractions in order to make the further processing of the recoverable material more easy. Drop-off centers for paper and glass can be also installed. In order to increase the amount of recoverable material it is essential to incorporate the informal sector (street collectors) into the existing system. The biochemical stabilization of waste before land filling is supported by the humification of organic matter. Industrial hazardous wastes need a special attention. This was demonstrated for phosphate sludges which could be successfully solidified in Turkey. Further options are recycling in the automotive industry and the production of phosphate fertilizers that are an increasingly limited resource for agriculture. Winery wastes contain highly valuable natural compounds like tartaric acid that can be isolated in industrial processes. Pathogens and chlorinated organic substances can be treated through gamma-irradiation and/or via environmentally-friendly heterogenic chemical catalysts.



As an important issue, **Risk Assessment, Mitigation Measures and Environmental Awareness** were dealt with in **Session 5**. For the purpose of risk assessment monitoring with biosensors are developed and used successfully. The knowledge and awareness of public groups for environmental problems were investigated comparatively in two different countries for school pupils, students, and adults. Younger people proved to have more knowledge on these issues than the older ones, since these subjects are introduced into the curricula just recently. It is, therefore, important to teach different aspects of environmental protection and sustainability at each level of education, beginning at primary and secondary schools, continued at higher education, and finally also taught in vocational and further education. **Teaching sustainability** for students of chemistry as future experts for hazardous substances and having enormous influence on production processes and emissions is of obvious importance. An internet based laboratory course for organic chemistry was demonstrated which does consider environmental safety as well as of sustainability. This course material is already translated into several languages and is available for free also in developing countries. Such approaches will help to disseminate the outcomes of scientific investigations and hopefully make people and public authorities aware of environmental protection and sustainability.

In the last **Session 6**, the participants discussed on all presentations given in each session and acknowledged the outcomes of this workshop. They identified urgent subjects that should be further treated in **Topical Networks**. Herewith, the workshop participants will sustain the links to international colleagues they made during this workshop. These **Networks** are (i) POPs Management and Mitigation, (ii) Brominated Flame Retardants and Alternatives, (iii) Water Management, (iv) Waste Management, (v) Soil Sciences and Humics, (vi) Sensors for Environmental Monitoring and Control, and (vii) Environmental Education. Each network will be chaired by an elected expert who is responsible for future cooperation of network partners. It was recommended to organize a follow up meeting in 2010 in Turkey and to report on the achievements obtained in the meantime.

## **Achievements**

The workshop deliverable was the draft document with conclusions and recommendations that was further discussed and modified considering participants' comments. During the closing session it was decided to create collaboration networks on workshop topics in order to sustain the links between the participants also in future.

The participants further agreed on the organization of a follow-up workshop or symposium in Ecological Chemistry in Konya, Turkey in 2010.

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