

TOCOEN PROJECT - GOALS, STATE AND PROSPECTS

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GOALS AND HISTORY

TOCOEN Project (Toxic Organic COmpounds in the ENvironment) is a non-traditional research project involving many Czech and Slovak universities, research institutions and various companies and at present also some universities and institutions from other countries, too (1-5).

The TOCOEN Project started in 1988. The basic goals of this project is investigation of the fate of selected organic pollutants in the environment. The fate includes investigation of emissions, their transport into compartments and between them, transformation (photochemical, chemical, thermal, biochemical), their effects (dose exposure analysis), modelling of risk assessment and management and prognosis of the contamination development.

As model compounds polycyclic aromatic hydrocarbons (PAHs), chlorinated pesticides (Cl-PEST), polychlorinated biphenyls (PCBs), dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) were selected. These are the original model groups of pollutants, now some other groups of pollutants such as chlorinated benzenes, phenols, some other types of pesticides, chlorinated aliphatic hydrocarbons and organometallic compounds are investigated.

Most serious attention is given to PAHs, PCBs and PCDDs/Fs. These classes of organic pollutants are compounds of highly persistent, toxic environmental contaminants characterised by extreme hydrophobicity. Many of them have positive genotoxic properties.

PCBs were/are widely used as industrial compounds, while PAHs, PCDDs/Fs are not industrial or commercial chemicals, but are formed as by-products of diverse processes. For example, PCDDs/Fs are formed during the incomplete combustion or incineration of organohalogen containing wastes and in car engine combustion processes.

These groups of model compounds are highly stable lipophilic chemicals; these properties are paralleled by their environmental persistence and preferential bioaccumulation at higher trophic levels of the food chain. PAHs, PCBs and PCDDs/Fs are present in various types of environmental matrices as highly complex mixtures of isomers and congeners. They occur throughout the environment and are found in all compartments of the ecosystem, including air, water, sediments, soil and various types of biota. These compounds do not move readily through soils and sediments because they become as a rule attached to particles. Soils and sediments represent the most significant "sink" for PAHs, PCBs, PCDDs/Fs. In these compartments they degrade very slowly, degrade and accumulate in biological tissue where they have long half-lives.

Polycyclic aromatic hydrocarbons (PAHs) are produced from almost any fuel when burned under oxygen-deficient conditions. Important anthropogenic sources of PAHs include

combustion of fossil fuels (gasoline, kerosene, coal, diesel fuel), waste incineration, coal gasification and liquefaction processes, petroleum cracking and the production of coke, carbon black coal tar pitch and asphalt (5).

Most PAHs are transported through the atmosphere and are ultimately deposited in marine and lacustrine sediments. Sedimentary PAHs concentrations decrease dramatically with distance from urban centres. Atmospheric deposition can be considered an important input source for the hydrosphere and soils. The further fate of the pollutants is determined by various physical, chemical and biological processes (6). The transport of PAHs through the soil is mainly influenced by adsorption-desorption processes, pollutant water solubility, soil factors and the hydraulic gradient.

Polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) are members of a class of organic pollutants which include polychlorinated naphthalenes, azobenzenes, and terphenyls; polychlorinated biphenyls (PBBs), and other mixed polychloro/bromo aromatics. PCBs are widely used as industrial compounds, while the PCDDs/Fs are not industrial or commercial chemicals but are formed as by-products of diverse processes (7). For example, PCDDs and PCDFs are formed during the incomplete combustion or incineration of organohalogen-containing wastes and in car engine combustion processes.

These TOCOEN model compound are assessed in all parts of environment - air (A), atmospheric deposition (RW), waters (W), sediments (SED), soils (S), aquatic and terrestrial biota (with bioaccumulation abilities). A new research subprogram is focused on problems of food contamination.

Biological indicators such as soil biota and plants have been used to monitor regional patterns of air pollution as well as atmospheric deposition of pollutants transferred over long distances. Earthworms can constitute an excellent monitor in the study of pollutant fluxes and a good example illustrating the state of contamination of a terrestrial ecosystem. Earthworms have been widely used for studies of the bioaccumulation and the toxicity of environmental pollutants, as PAHs, PCBs, chlorophenols and 2,3,7,8-TCDD also. Earthworms are a very suitable system for these investigations.

Very suitable natural monitors of emission levels in the environment are mosses, pine needles and lichens. Various types of plants are natural monitors for organic pollutants such as PAHs or PCBs and PCDDs/Fs.

The first TOCOEN aim was to model the fate of selected organic pollutants. In 1988, we had two possibilities - modelling according to data in the literature but without actual assessment and without concrete knowledge about the state of contamination in former Czechoslovakia or to make our own measurements. We selected the second way and the period from 1988 to the present time can be described as the first

TOCOEN period, the first phase, the time of basic measurements and monitoring.

The monitoring can be described as scientific monitoring without official, governmental funding.

Many potential sources of these harmful compounds existed in former Czechoslovakia, and still exist in both parts: the Czech or Slovak Republic. Many of them are unknown or little known - these known and unknowns sources constitute the system of "Chemical Time Bombs" - for the present or next generations not only in the Czech and Slovak Republic, but also other neighbouring countries or far away from this "dangerous system".

TOCOEN model compounds were observed so far in ten places. There are four types of model sites. The first type are very heavily polluted areas - a combination of industrial and urban type of pollution (Brno, Ostrava, Praha, northern Bohemia). The second type are typical agricultural landscapes (southern Moravia, near the Nové Mlýny dam). The third type of model site are model sources of observed compounds (PAHs: DEZA Valašské Meziříčí - a chemical factory producing aromatic and polyaromatic compounds, phthalates and carbon black; coal and gas fuel company Vřesová; PCDD/Fs - municipal waste incinerators in Brno and in Praha, industrial waste incinerators in oil refinery OSTRAMO Ostrava). The last, but not least important type of model sites are background sites, for example the GEMS (Global Environmental Monitoring System) at Košetice, southern Bohemia, or the Fryšánka catchment area, Bohemian-Moravian highlands.

The field work began in 1988. The sampling time at TOCOEN model sites is as follows:

The surroundings of Lachema chemical factory - 1988, 1989, 1990, 10 sampling sites.

The surroundings of Brno municipal waste incinerator - 1989, 1990, 1991 - 12 sampling sites.

The surroundings of the Nové Mlýny dam - 1988, 1989 - 10 sampling sites.

GEMS Station Košetice - background site - 1988, 1989, 1990, 1991, 1992 - 20 sampling sites.

The catchment of river Fryšánka, Bohemian-Moravian highlands (only a few samples of sediments and biota).

The surroundings of the chemical factory DEZA Valašské Meziříčí - model source of PAHs - 1989, 1990, 1991 - 63 sampling sites.

The surroundings of the industrial waste incinerator LIAZ Mnichovo Hradiště - model source of PCBs, PCDDs/Fs - 1990 - 10 sampling sites.

The surroundings of the industrial waste incinerator and chemical factory TECHNOPLAST Chropyně - model source of PCBs, PCDDs/Fs - 1989, 1990 - 4 sampling sites.

The surroundings of the oil refinery OSTRAMO Ostrava and very strong polluted area of Ostrava region - model source of PCBs, PCDDs/Fs - 7 sampling sites.

The surroundings of a new municipal waste incinerator in Praha and very strong polluted area of Praha region - model source of PAHs, PCBs, PCDDs/Fs - 5 sampling sites.

The surroundings of the coal-conversion factory Vřesová - model source of PAHs - 21 sampling sites.

The most problematic TOCOEN results are the results concerning the contamination of the Czech and Slovak environments by PCBs, PCDDs/Fs. From this aspect the situation of environmental contamination in Czech and Slovak republics by these compounds is not very favourable and optimistic and this situation can have a catastrophic character in some parts of the country. The examples are documented in older papers and lectures and posters from TOCOEN 93.

PRESENT STATE

TOCOEN 93 is a good opportunity for recapitulation of goals and plans of the TOCOEN Project. We can state that this first, original goal concerning the recognition of the state of contamination by TOCOEN model pollutants was implemented "semi-systematically". Now we have space- and time-limited first information from various polluted areas from the TOCOEN Project in Teplice, Elbe, Chemical Time Bombs. We can compare various regions of our country, but estimation of risks, prognosis, of the development of this contamination is impossible so far. Data from this measurements are warning and indicate serious dangers of these pollutants for various type of biota including man.

On his first scientific basis, we discussed more general aspects of our work. One, probably the most important goal, was concerned the constitution of environmental chemistry and ecotoxicology, as a scientific branch in former Czechoslovakia. And now we would like to continue in the implementation of this aim in the Czech and Slovak republics.

Our basic method of work was and is to create free scientific teams with a high degree of freedom, but closely connected by ideas of common scientific interest, tactful relationships doing more than normal obligatory work.

We contacted environmental chemists from many countries and started with international cooperation. The TOCOEN Project originated from the work of many well known groups. The TOCOEN Project was founded in Jyväskylä; Jaakko Paasivirta was the first spiritual adviser and father of this Project. Our cooperation continues and we hope it will continue in future. Now we have many other contacts with environmental and ecotoxicological working groups from USA, Sweden, Norway, the Netherlands, Germany, Poland and other countries.

TOCOEN people participate in many international projects - Task Force on Persistent Organic Pollutants, Chemical Time Bombs, Elbe, Donau, Odra, cooperation with US EPA (Project Teplice, Silesia), GEMS activities (food, air).

TOCOEN people established last year the Czech and Slovak Society for Environment Chemistry and Ecotoxicology (CSECETOX and SSECETOX) as a professional society with contacts with SETAC and SECOTOX.

PROSPECT AND PERSPECTIVES

We would like to continue in our scientific activities in future. We foresee the following future basic goals:

- advancement of Czech and Slovak environmental chemistry and ecotoxicology and its international acknowledgement;
- for our work we need high quality of assessment data - in our countries we do not systematically use the system of quality assurance/quality control. Our management and many scientists have problems with basic terms in this field and this limits our international cooperation and acknowledgement of our work;
- on this base we can start with risk analysis, evaluation of negative effects on various parts of environment and various types of biota including man, environmental impact assessment;
- transfer from the level of preliminary recognition to level of environmental research. Our main work is focused on routine work - the determination of pollutants in various environmental compartments, food, man. It is a very important part of environmental work (control, monitoring), but in our countries also a part of the environmental and ecotoxicological research. We lag behind world

progress, we cannot wait only for help from some foundation etc. It is necessary to start with our own activities.

From this reasons we would like to concentrate the TOCOEN Project activities on the following topics:

- identification of new types of pollutants in our environment,
- research of their physico-chemical and environmental-chemical properties,
- environmental fate, exposure and effects,
- modelling the fate of selected pollutants,
- research of bioaccumulation of pollutants,
- risk assessment and risk management,
- methods of biodegradation,
- inventory of sources of pollutants,
- quality assurance/quality control as the base for all other topics.

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