Methodological Guidelines for Contaminated Site Assessment - the Czech experience

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Abstract

Expert site assessment, based on field geochemical investigation, is the only possible method how to discover or how to monitor contaminated land and water pollution. In spite of this irreplaceable basic role for problem identification and evaluation, there is often more attention given to the successive (computational) elaboration of data or to the presentation of the final conclusions.

The acquisition of relevant and reliable input information represents a complicated task which importance has to be highlighted as a vital part of the assessment. The Czech experience and expertise in this sphere is currently being driven by an ongoing process of wide privatization, which is connected with the necessity to solve problems caused by former environmental damages or at least to identify the problems, to evaluate their urgency and to propose solutions.

Introduction

The start of the privatization in the Czech Republic helped to expose a lot of contaminated sites and evoked the need for an acceptable general solution. The government and the parliament prepared (in a short time period) a raft of quite new environmental laws mostly comparable with European standards and also announced the responsibility of the State for the environmental damages demonstrably caused by the former regime.

This framework of strong, new environmental policy and partial support from the State accelerated the rise of the „ecological market.“ The positive determinative factor was the high professional level of the Czech geology, hydrogeology and engineering. On the other side, the negative determinative factor was, in the first phase especially, the lack of practical experience with effective environmental management. These factors influenced the first years of a „new wave“ in environmental protection and showed both strong and
weak points of both assessment and decision-making process. Nowadays, there
is a time for implementation of new guidelines which ought to improve the
practical realization of „environmentally sound“ procedures.

Although the Czech Republic has inherited a lot of (not only
environmental) problems from the past, the advantage of an existing
interactive relation between practical experience and implementing new
regulations in the sphere of environmental protection is evident.

1. Methodological background for contaminated site
assessment

At sites of potential soil or water contamination, the first-rate initial
geochemical survey and professional evaluation of relevant „archive“ data
form the basic and the most important steps prior to the complete field
investigation, remediation, future preventive measures or new investments.
Any mistake or neglect at the beginning of the project could significantly
handicap the results. That is why it is necessary to enforce stringent procedures
upon the recent state assessment and by means of it to ensure reliable inputs
(including the system of feed-back) for the decision makers.

With regard to the experience acquired while solving various types of
practical problems connected with hundreds of environmentally damaged sites
in the Czech Republic, our company AGSS is convinced that the unification of
objective and generally applicable assessment methods is inevitable. Although
small private consultancy companies of our type are dependent on customers
with (ecological) problems, we see that the local solution may not to be
enough. Therefore, we are focusing our activities even to the standardization
of procedures applied - in the frame of the up-to-date Czech (and international)
environmental laws, norms and regulations. These activities of AGSS resulted
into cooperation with the Czech Ministry of Environment in implementation a
new system of methodological recommendations, focused especially on the
most problematic process of the elimination of former environmental damages
(the sphere of the new investments is quite sufficiently covered by the
obligatory environmental impact assessment procedure, the sphere of
environmental management will be likely covered by the acceptation of
international standards, namely of ISO 9000 and 14000).

Among others, the following relevant guidelines are already in force (or
they are about to come into force):

- Ecological Audit (ie the assessment off current environmental damages
  caused by historical impacts - the ongoing pollution sources have to be
distinguished);
- Risk Assessment (evaluation of the current risks and consequences);
- Soil, Water and Soil-air contamination criteria (setting of auxiliary
  comparative limits for the needs of decision makers);
Atmogeochemical Survey (detection of organic contaminants in the soil-air as the screening method for the land contamination assessment);

Supervision on remedial activities (methodology for checking the effectiveness of the most expensive stage of environmental protection).

All these guidelines reflect the earlier practical experience with land and water pollution and they are used as a code of practice by the Czech Environmental Inspection, Ministry of Environment or National Property Fund as well as by the local authorities. A common feature of these materials is the fact that they emphasize the significance of an expert assessment of the pollution problems.

1.1 Ecological audit

Ecological audit - the former environmental damages identification and evaluation - is an obligatory part of any privatization project. The Czech methodology recommends two connected blocks for the final report:

- **Protocol of ecological audit** - which includes questions which could be answered on the basis of the field recognition and by the evaluation of accessible documents and data, namely:
  - general information on the site and on the enterprise assessed;
  - history of the site;
  - natural conditions;
  - soil and water contamination (accessible information);
  - emissions;
  - water management;
  - hazardous materials management (character; storage, manipulation);
  - tanks and pipelines;
  - asbestos and fibres;
  - radioactive materials;
  - waste management;
  - order on the workplace;
  - emergency plans;
  - work safety and health protection;
  - noise and other physical factors;
  - energy management;
  - compliance with relevant regulations;
  - uncertainties and recommendations.

- **Geochemical investigation, complex evaluation, proposals of follow-up measures**; a step by step procedure is recommended:
  - accessible data evaluation, field recognition, project of the field investigation;
field screening (sampling of current sources of ground or surface water, atmogeoechemistry, shallow probes for sampling soil or wastes, geophysics, etc.);

basic survey (geology, hydrogeology, engineering geology, hydrogeochemistry, technical works);

detailed survey (specification of horizontal and vertical extent of contamination, verification of the results or hypotheses, special tests, models, etc.);

complex evaluation of data;

determination of environmental damages;

proposals for remediation (if necessary) or monitoring;

time and costs estimation for the follow-up program.

The final report on ecological audit has to be supplemented by a judgment from Regional Departments of the Czech Environmental Inspection and of the Czech Ministry of Environment.

The expenses for the ecological audit are covered by the current owner.

1.2 Risk Assessment

The current Czech methodological model for the risk assessment has two basic steps:

- **Preliminary risk analysis** does not include a field survey, but emerges from the following accessible information or presumptions:
  - final report on ecological audit;
  - land-development and land-use plan;
  - surface water exposure assessment;
  - ground water exposure assessment,

and leads to an *evaluation of proved or potential risks*. Based on this evaluation, one of the four priority levels is ranged with the site:

- **category 1** (non-accepted risks, remediation necessary); the in-depth risk assessment follows;
- **category 2** (potential risks, necessity of remediation probable); the in-depth risk assessment follows;
- **category 3** (likely without weighty risks, remediation not presupposed); the in-depth risk assessment is facultative;
- **category 4** (risks not probable, no remedial activity presupposed); the in-depth risk assessment is not necessary.

- **In-depth risk assessment** ought to establish the risk level and to state the necessity and extent of remedial measures; the purpose-focused field investigation for the uncertainties minimization is presupposed. The basic chapters of a risk assessment are as follows:
Water Pollution

- introduction, general information on site (land-use, natural conditions, special regime, etc.);
- hazard identification (applied investigations; risk sources; character, level and extent of the priority risk factors; uncertainties);
- exposure pathways - recipients (environmental fate of contaminants, unsaturated and saturated zone parameters, evolution of migration, environs);
- human risks assessment (dose - response relationship, exposure scenarios, risk characterization);
- environmental risks assessment (land-use, eco-toxicity, exposure models, risk characterization);
- risk summary (total risks, factors of priority, preferential pathways, uncertainties and restrictions);
- remediation proposal - target values (admissible risk level, variants of remediation and their efficiency, target values and residual risks);
- conclusion and recommendation (recapitulation of the results, consequence assessment, optimum procedures proposal).

The final report on risk assessment has to be supplemented by a judgment from Regional Departments of the Czech Environmental Inspection and of the Czech Ministry of Environment.

If the Czech government approves, on the basis of the ecological audit results, at least a partial compensation of remedial expenses for the site owner, the National Property Fund of the Czech Republic could cover the expenses for the risk assessment. If the risk assessment is ordered by the Czech Environmental Inspection (especially in the case of accidental damage of waters), the expenses has to be covered by the polluter.

1.3 Soil, Ground Water and Soil-air contamination criteria

The Czech Ministry of Environment recommends, by means of this guideline, the criteria of contamination of soil, ground water and soil-air (intervention values) to be used for the task of assessment of contaminated land and old environmental liabilities and for the decisions to be taken for remediation. The „Dutch list“ and other European limits were used as the basis for this guideline; other relevant Czech norms (especially the potable water limits) and land-use plans were considered, too.

It is recommended to use the criteria especially in the following phases of the soil and ground water contamination assessment and of decision-taking about the remediation:
- assessment of the contamination of soil, ground water, soil-air and substances coming from construction activities;
- assessment of the necessity to start monitoring or investigation at the given locality;
- assessment of the necessity to carry out a risk analysis;
- enumeration of the environmental damages, estimation of the expenses for possible corrective measures (for reducing the contamination to the value of the criterion C or to the value recommended by the risk analysis);
- decision about corrective measures;
- assessment of the impact of old dumps;
- assessment of proprieties of the removed soil and remaining construction substances;
- filing of contamination as an environmental liability.

The “intervention values” are determined in the following way:

- Criteria A correspond approximately with the natural content of the substances in the environment (in connection with conventionally fixed limits of analytic methods sensibility) - exceeding the criteria A is classified as contamination of given element of the environment;
- Criteria B are artificially introduced criteria which are given for the substances approximately by the arithmetical average of criteria A and C - exceeding the criteria B is considered as contamination which can have negative impact to the human health and to the elements of environment - exceeding these intervention limits signals the necessity to treat the contamination (investigation, monitoring, risk assessment);
- Criteria C are estimated on the basis of supposed exposures of man with the use of model calculations; criteria are presented for different types of the land-use - exceeding the criteria C represents contamination which may signify considerable risk for human health and for elements of the environment; the significance of the risk can be confirmed only by analysis (recommended target values, dependent on the risk assessment result, can be higher than the quoted criteria C).

1.4 Atmogeochemical Survey

Our experience has shown that the optimum process for the initial site assessment (apart from the historical desk study) is a combination of atmogeochemical survey with classical geological and hydrogeological methods. The term "atmogeochemistry", not so usual abroad, is a general Czech term for the methods of volatile organic pollutants (VOC) detection in the soil or atmospheric air. The choice of the proper method depends on the purpose of the survey and its effectiveness is given by suitable procedures within the projection, field performance and by results interpretation.

As the principles of classical soil or water sampling are well-known and they are largely supported by existing both Czech and European norms, this guideline - specially dedicated to the performance of atmogeochemistry and to its position in the frame of other investigation or monitoring methods - is
presented as a first attempt to unify the procedures used (from project to final elaboration). As the development of the method is quite rapid, new dependencies could be discovered.

There are several main types of problems (connected with „volatile or semi-volatile organic compounds“ contamination) which could be solved, at least partially, by means of atmogeochemical methods:

- **preliminary assessment - determining the sources and the likely extent of contamination** (especially in the screening stage of the investigation);
- **identification the type of contaminants**, e.g. chlorinated or aromatic hydrocarbons (especially for the purposes of risk assessment or for the choice of analytical methods for assessing contamination of other media);
- **determining the distribution zones of contaminants** (e.g. for distinguishing „primary“ contamination of unsaturated zone from „secondary“ contamination aureole coming from polluted ground water);
- **tracing of migration channels or zones of accumulation** (the volatility of the compounds detected enables to indicate - in special cases - even the contamination spreading by means of ground water);
- **long-term monitoring or preventive arrangements** for the hazard or, on the other hand, specially defended sites - where accidental leakage can be detected before reaching ground water or before uncontrolled spreading (timely and costs-saving arrangements are then possible);
- **determining the dynamic parameters of unsaturated zone**, e.g. for the purpose of installation of venting (no other method is so convenient);
- **feed-back program for checking the effectiveness of remediation** (indication of both quantitative and qualitative changes of the contamination in situ), etc.

The advantages of atmogeochemical methods are evident:

- minimum terrain restrictions (as to the accessibility of the sampling points) - the shallow probes (within the screening usually to the depths of 2 meters, with the diameter to 35 mm) are sufficient and can be drilling by portable drilling sets;
- a larger sampling radius (when using dynamic methods) than in soil sampling, without gross disturbance of natural ground conditions;
- more reliable detection of volatile or semi-volatile organic compounds against the soil sampling, relative comparability with the ground water sampling (especially in qualitative indicators);
- immediate in situ information is available (when using portable detectors), although the laboratory analyses are preferred;
- relatively cheap analytical procedures with a sufficient qualitative and quantitative output information (GC/ECD,FID; GC-MS in special cases);
- possibility of the permanent sampling sondes installation for a monitoring of unsaturated zone (several depth levels can be monitored separately; the stable sondes can be easily modified for an immediate - emergency - local remediation or leakage stabilization by means of „mini-venting”);
- rapidity and costs-effectiveness of the field investigation, and subsequently the higher effectiveness by projecting and focusing the classical survey methods (hydrogeological boreholes location, choice of relevant spectrum for chemical analyses, etc.).

1.5 Supervision on remedial activities

The need for methodological guidelines for checking the effectiveness of remedial activities arose from the fact that a significant part of the costs for these activities is paid by the Czech State - by the Ministry of Environment (which is responsible for the remediation of the former Soviet Army sites) and by the National Property Fund (which is responsible for the remediation of privatized sites). The Czech Environmental Inspection has a role of a State supervisor for all the environmental problems (and this fact limits its professional capacities).

As the remediation is usually a very expensive and a long-term process which cannot be monitored only by the office-holders, a tender system was developed for establishing the panel of professional supervisory companies and experts. Guidelines determining the responsibilities of both remedial and supervisory teams were also prepared.

The following objectives are specified for the supervision:
- position and role of the supervisor (timing and extent of the works and definition of objectives and responsibilities for the assurance of the basic aim: the feed-back on the effectiveness of the remediation);
- guarantees on the role of the supervisor (independence on the subject to be supervised, objectivity, professionalism);
- duties of the remedial organization (obligatory documentation of the works, accessibility of the relevant data and information);
- duties and competencies of the supervisor (free access to the information sources, obligatory documentation, responsibility for the results, secrecy);
- objectives of the supervision (control of project and works conformity, of documentation and of procedures approved; verifying field measurements; complex elaboration of all accessible information; recommendation for the follow-up program; professional opponency);
- procedures of the supervision (assessment of the „archive“ data; field recognition; project of the supervision; field investigation including check-up sampling and analyses; applied procedures, documentation and
regulation compliance control; assessment of the trend characteristic; complex evaluation; proposals);

- structure of the final report (introduction, site characteristic and natural conditions, results of the former investigation and remediation, results of supervisory works, actualized risk assessment - if necessary, complex evaluation of the remediation effectiveness and recommendations for the follow-up program, conclusion; appendixes and documentation).

The supervision is usually paid by the Ministry of Environment or by the National Property Fund of the Czech Republic (the expenses for the complex and running supervision vary between 2 - 5% of remediation costs). The supervisor for the given locality is chosen by means of a public tender from the panel of experts (which could be modified likely in two years period). To eliminate possible conflict of interest, there is an intention to minimize the participation of remedial organizations in carrying-out the supervisions.

2. General aspects of water pollution

Water pollution is only accidentally caused by primary leakage of the pollutants. Usually, the water pollution is an “end-of-pipe” indication of chronic problems connected with outworn technologies, long-lasting soil contamination, imperfect waste management, etc. That is why the problems of water pollution cannot be defined (let alone solved) only by simple technical methods, although the rapid development of field survey technologies, analytical kits or computational programs evidently helps. The practical experience of each executive team and its professional capacity and responsibility all the time will prevail over, however more expensive may be, „user-friendly“ commercial products.

Water pollution needs an interdisciplinary (human-made) solution: the following factors, among others, ought to be taken into consideration:

- geological, hydrogeological, technological and ecological features of the given locality;
- historical background, recent and future development of potential sources of contamination;
- physical and chemical characterization of the pollutants (in the context of fixed natural conditions);
- migration pathways (surface wash-off, primary/accidental contamination, secondary/chronic contamination e.g. from unsaturated zone, along technological networks or following natural features, impact of emissions, etc.).
Water pollution - as a demonstrable indicator of the problems - needs the solution (**what to do**), the solution needs the decision (**what is the priority**), the decision needs the relevant and sufficient inputs (**what is the problem**), the compilation of relevant and sufficient inputs needs an effective methodology (**how to find and prepare the useful data**), all the system needs an investor (**who and why will pay**), the investor needs value for his money (**what is the result**), the evaluation of the outputs needs feedback and monitoring (**how to prove the effectiveness of the solution**).

All the facts above mentioned mean that problems of water pollution cannot be separated from other environmental problems. On the contrary, only the integrated approach can bring the most useful results.

### 3. Conclusions

The Czech Republic has a large number of environmental problems accumulated from the past, and the necessity to solve these problems in a very short time period has meant rapid progress in the field of methodologies and guidelines for contaminated site assessment. This extensive practical experience, and the ability to find effective solutions to the problems of contaminated land, could be useful for other countries in transition as well as for countries with a historically high standard of eco-management.

The Czech experience in the sphere of environmental protection has shown that the connection between theory (including the development in modelling, measuring and prediction) and practical applicability is vital.

Anyway, Nature will always have its secrets and specifics which could not have been numerically controlled, and sustainable development will always need both common sense and a lot of investigation and research.

### References:


