Tools for More Effective Management of Accidental Surface Water Pollution Cases

Premysl Soldan

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International Commision for the Protection of the Odra River Against Pollution

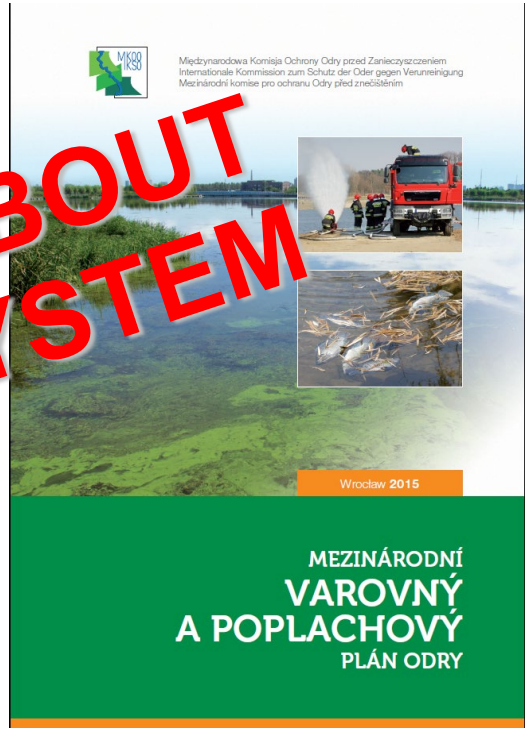
Working Group 3 (CZ – PL – D)
ACCIDENTAL POLLUTION

The Odra River Emergency Plan

The Odra River Emergency Plan gives some very general information about the objects and areas requiring special protection and about possible sources of accidental pollution in the international Odra river basin. System of accident documentation and assessment and suggested procedures in case of accident are descibed very generally, too.

The Odra River International Warning and Alarm Plan mainly describes a system for transmitting information in the event of cross-border accidents.

NO INFORMATION ABOUT EARLY WARNING SYSTEM



The Odra River International Warning and Alarm Plan

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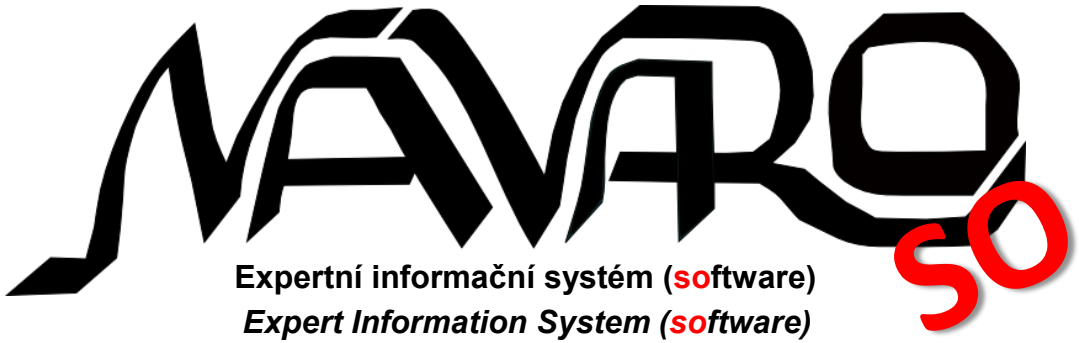
Projects financed by the Technological Agency of the Czech Republic

VÝVOJ NÁSTROJŮ VČASNÉHO VAROVÁNÍ A REAKCE V OBLASTI OCHRANY POVRCHOVÝCH VOD

DEVELOPMENT OF TOOLS OF EARLY WARNINNG AND REACTION IN THE FIELD OF SURFACE WATER PROTECTION



Expertní informační systém (software)

Expert Information System (software)

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NAVARO

Development of certified method describing tools of fast detection of dangerous surface water pollution accident and its sources including accidents, terrorist or criminal actions

The main topics described:

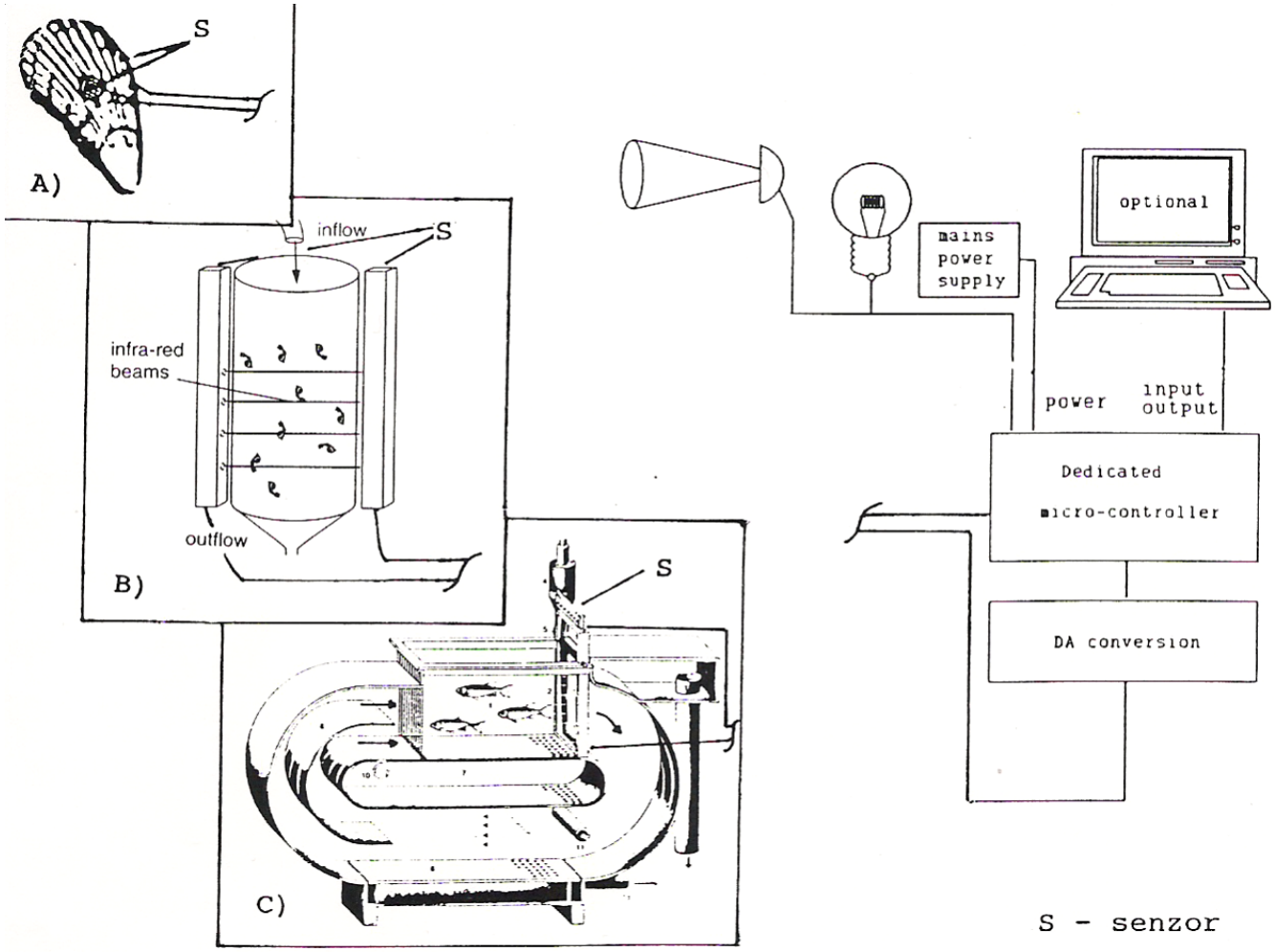
- **recommended structure of an early warning system**
- **use of continuous monitoring for detection of pollution accidents**
- **criteria and process for declaring the accident**
- **recommended equipment of mobile analysis units**
- **recommended analyses *in situ***
- **recommended field protocols**

Current routine continuous monitoring in the Odra River basin

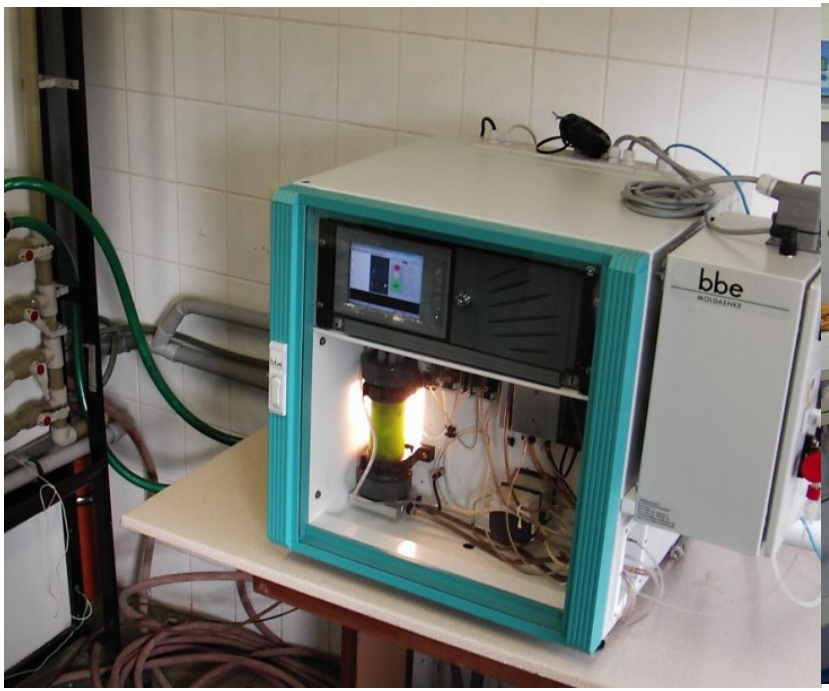
- **pH** - possible accidental spills of substances of extreme values of pH - but marked changes in the pH of water of an aquatic environment are also of natural nature (e.g. during summer months due to high photosynthesis activity of masses of autotrophic organisms – increase of pH value to 9 even more) – it is hard to set alarm limits.
- **O_2** - possible accidental spills of substances which damage nature (e.g. nitrites, untreated sewage waters, etc. – but significant changes in O2 concentration during the day are again natural in highly eutrophic waters – the setting of alarm limits is difficult.
- **conductivity** - measurement detects changes in the total content of salts in monitored water; analysis is more sensitive to smaller (univalent) ions with higher mobility; utmost response is for H+ and OH- ions – so for this parameter it can be stated the same as for the measurement of pH.
- **temperature** - possible spill of hot waters – but in respect of the high-temperature capacity of the water body spill impact is detectable only in a short segment of recipient water.
- **UV absorbance** - at a wavelength of 254 nm a lot of organic substances show absorbance, especially those which contain one or more aromatic rings; but these substances have limited solubility in water and in addition, the usual level of absorbance of surface water is rather high.

CURRENT TYPE CONTINUOUS MONITORING IS LOW EFFECTIVE FOR ACCIDENT DETECTION

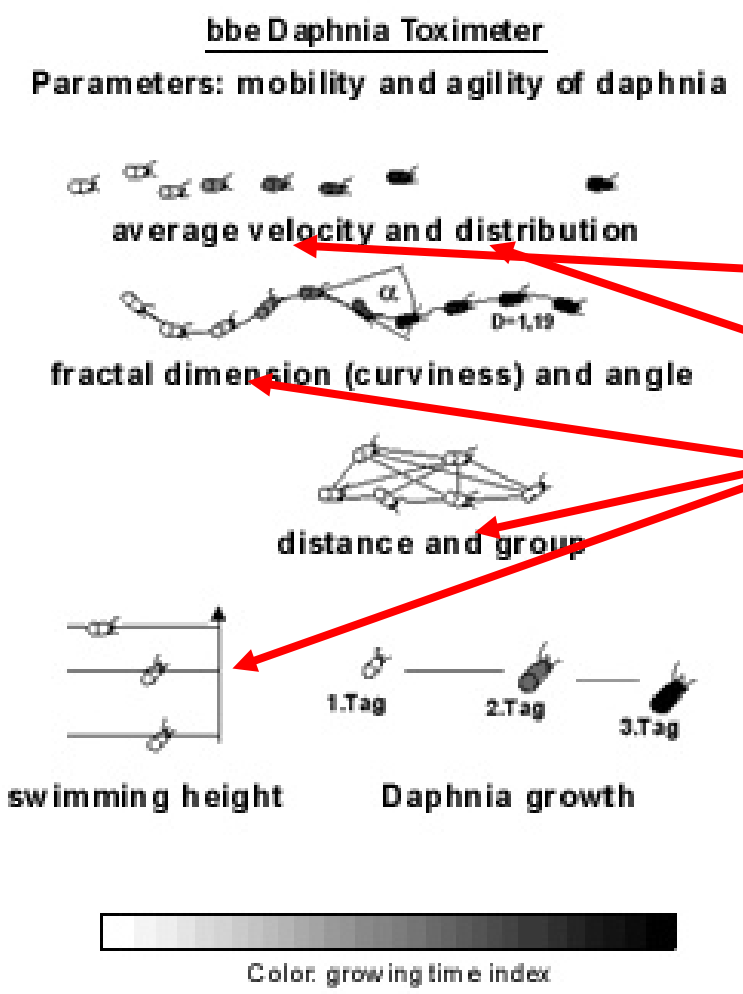
Devices of Continuous Biological Monitoring

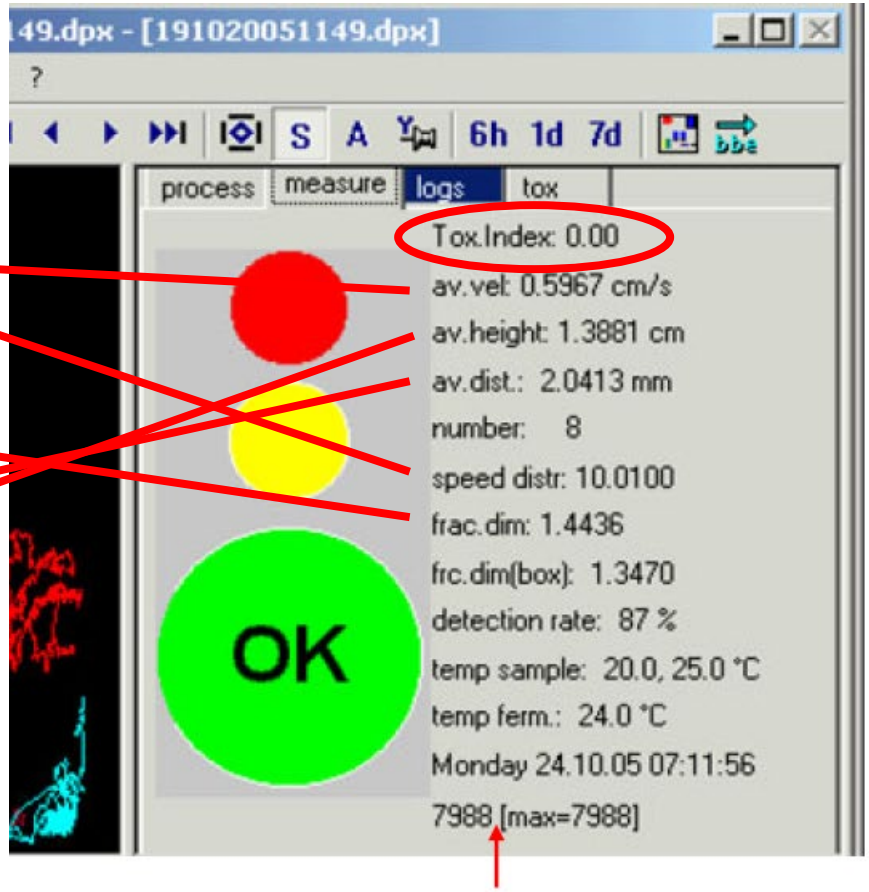


Daphnia Toximeter



Daphnia Toximeter





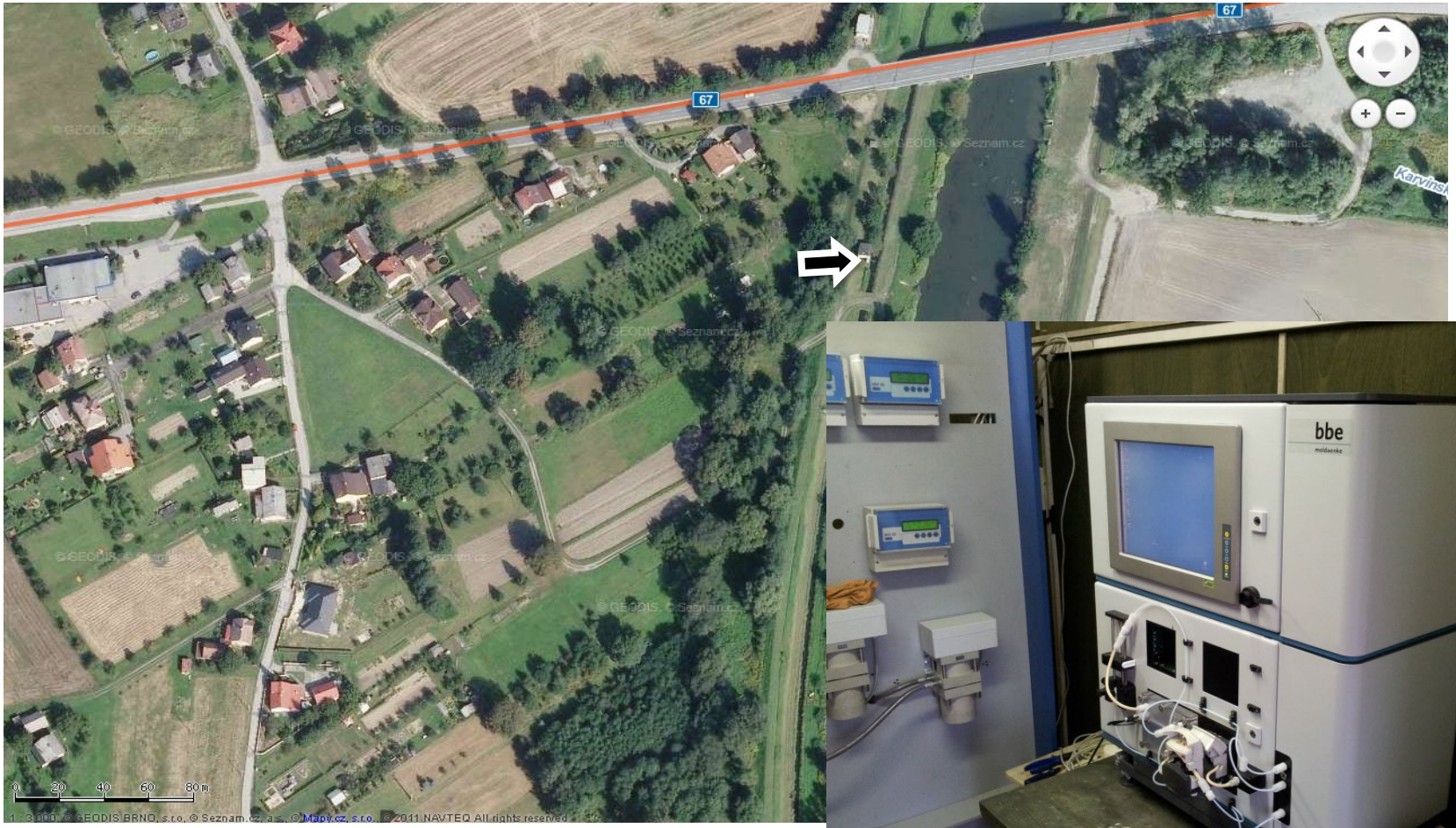
sion

of particular organisms

numerical expression of organisms
behaviour parameters
and of other measured values

Monitoring station on the Odra River in Bohumin

Monitoring station on the Olse River in Detmarovice



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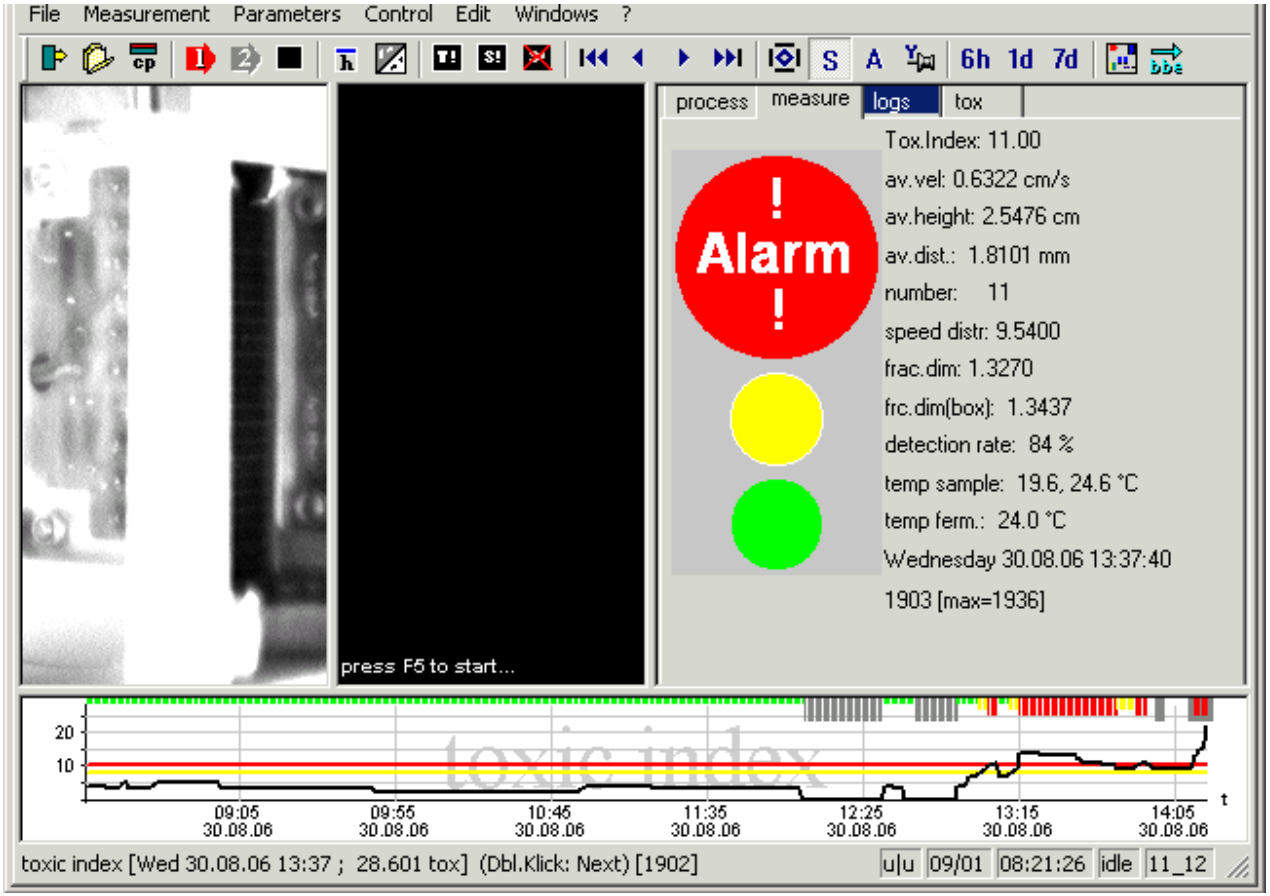
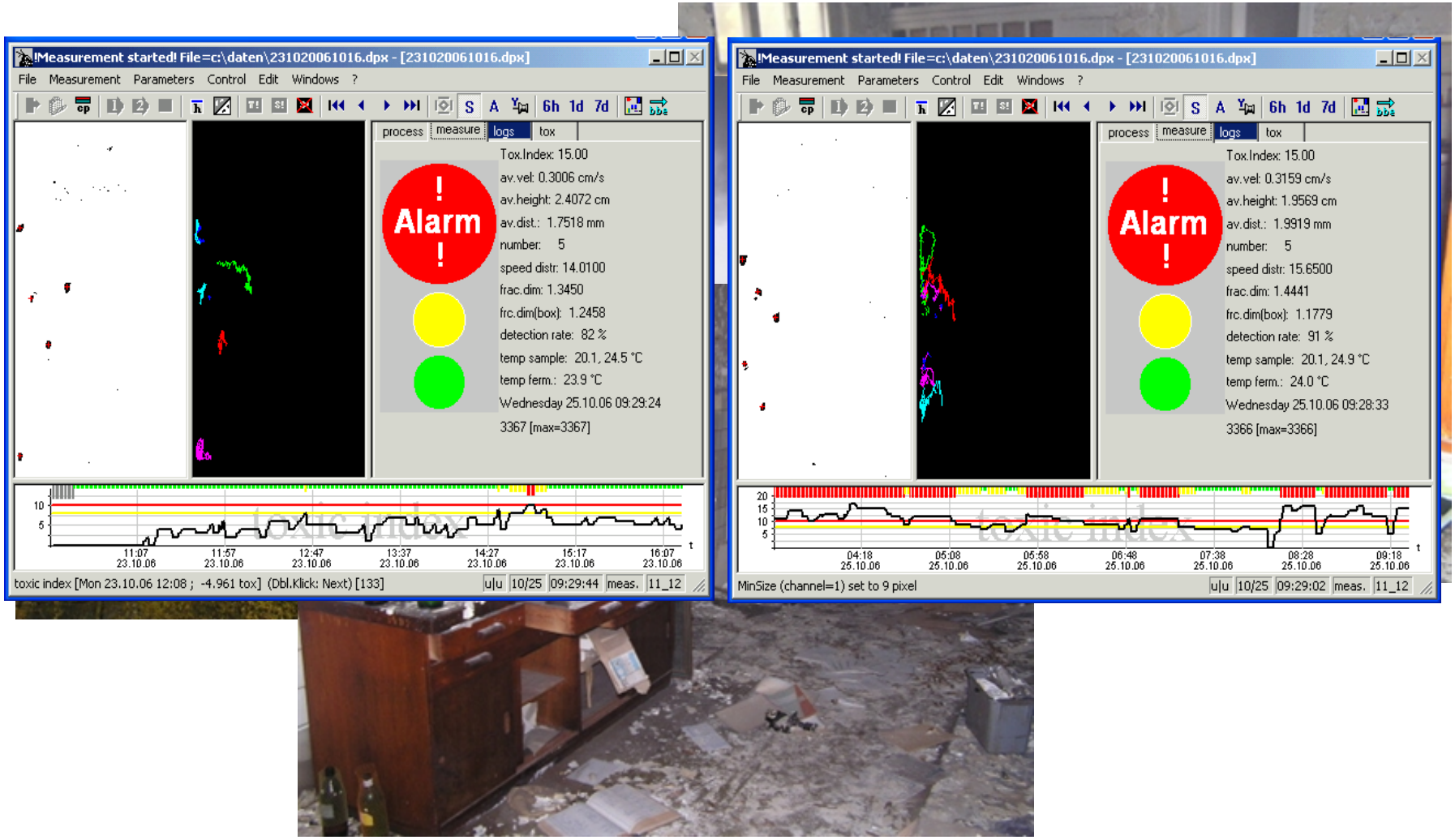
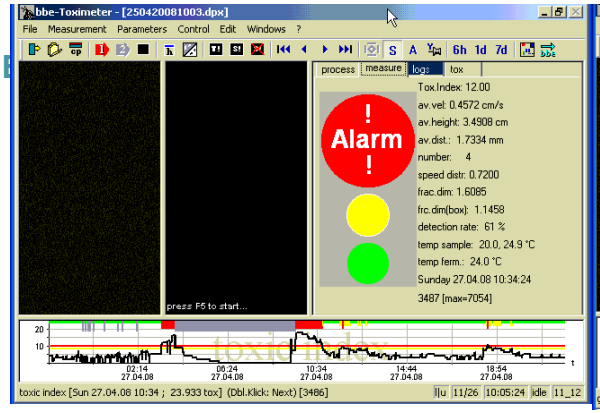
Accident - BorsodChem-MCHZ

Pollution Spill of benzenes from BorsodChem-MCHZ Ostrava on 30.8.2006

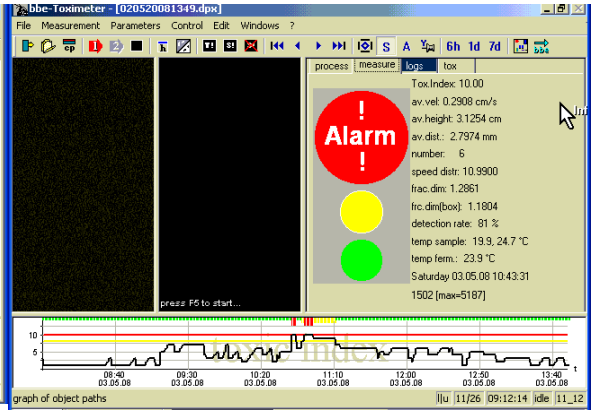


Fire Accident in Ostrava-Hrusov

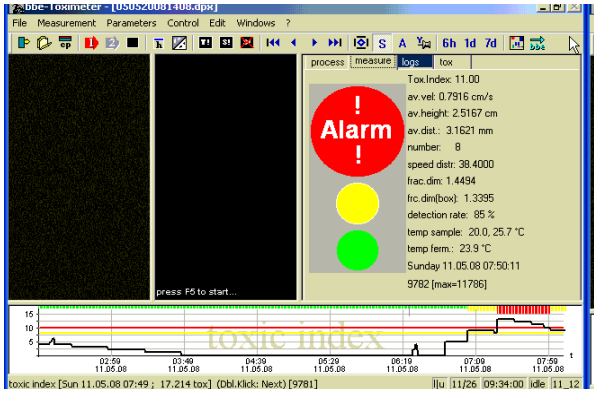




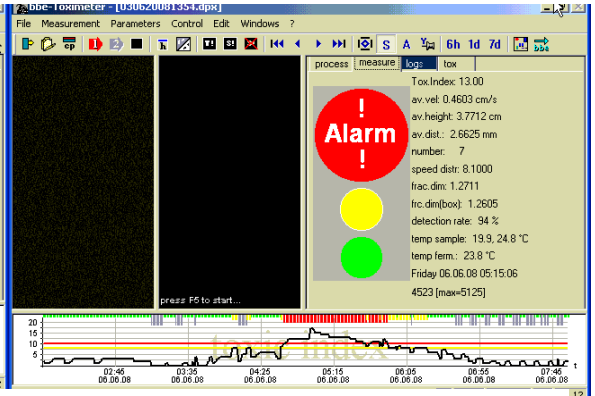
NE 27.4.2008 3,00 – 4,15 h a 9,30 – 10 30 h



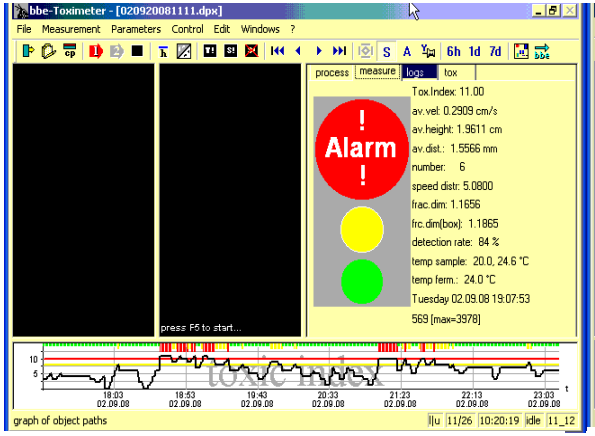
SO 3.5.2008 10,30 – 10,55 h



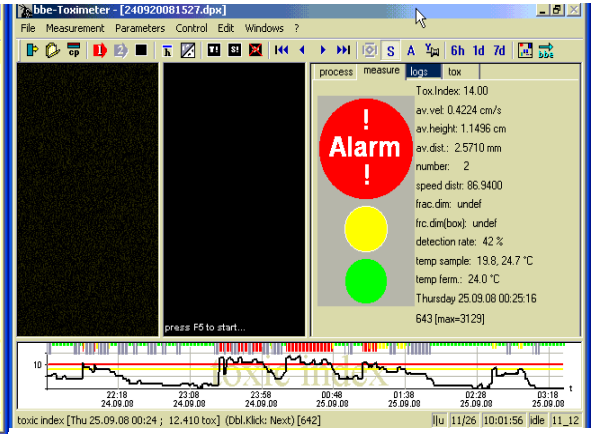
NE 11.5.2008 7,20 – 7,55 h



PÁ 3.5.2008 4,40 – 5,20 h



ÚT 2.9.2008 18,35 – 19,20 h a 21,00 – 21,40 h



ČT 24.9.2008 23,20 – 0,30 h

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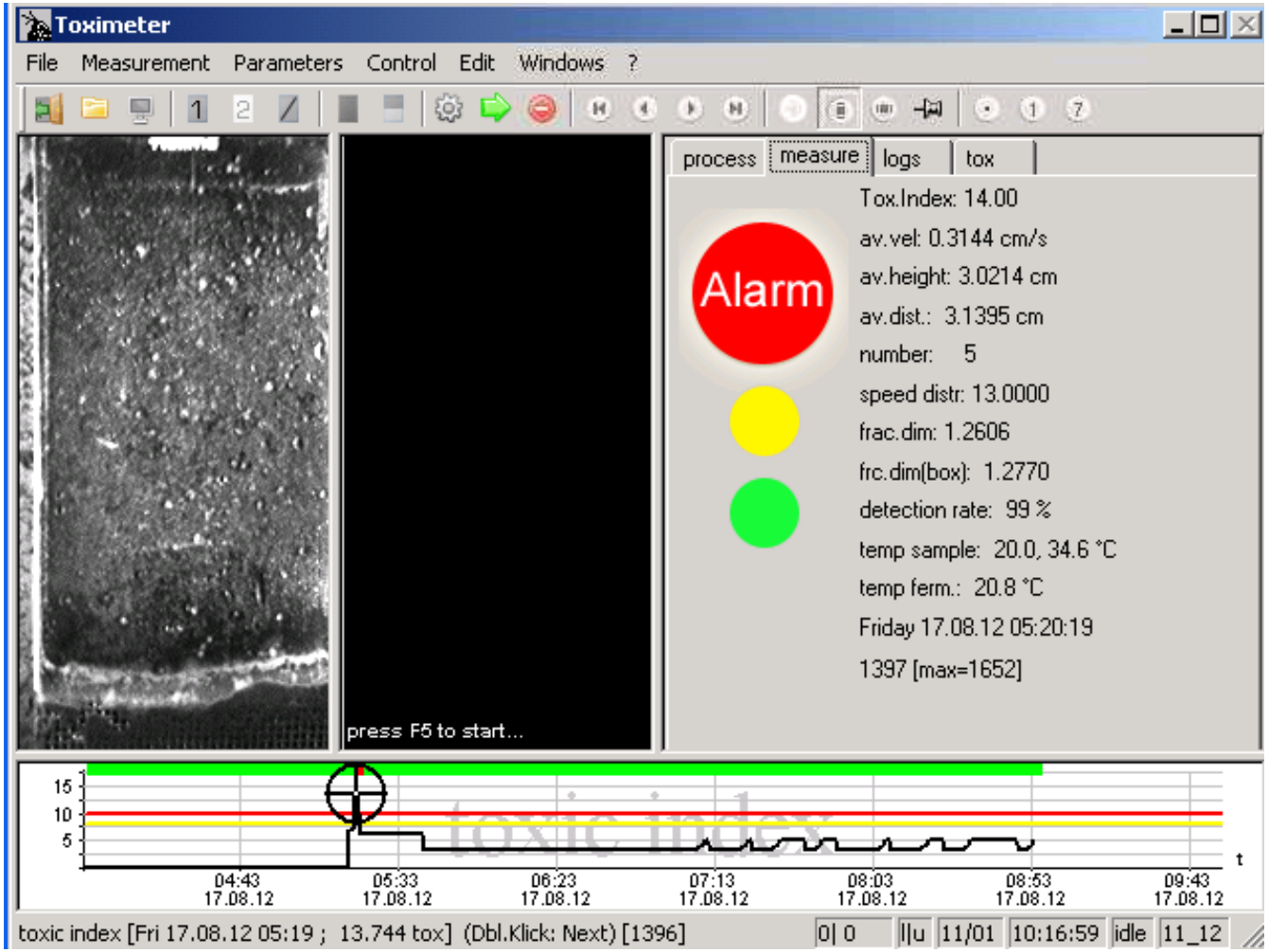
Detection of accident causes

Detection of accident causes



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Detection of accident causes

číslo vzorku		403	404	405
označení vzorku	jednotka	alarm	1 h po alarmu	2 h po alarmu
reakce vody		8,1	8,0	8,0
elektrická konduktivita	mS/m	**103**	**103**	**103**
chloridy	mg/l	**147**	**152**	**150**
sírany	mg/l	**127**	**123**	**118**
kyanidy	mg/l	0,006	0,006	0,005
jednosytné fenoly	mg/l	<0,004	<0,004	<0,004
fenol	µg/l	1,43	0,672	0,584
m,p-kresol	µg/l	1,99	1,91	2,086
2-nitrifenol	µg/l	<0,5	<0,5	<0,5
4-nitrofenol	µg/l	0,988	0,831	0,469
2,4-dinitrofenol	µg/l	<0,1	<0,1	<0,1
naftalen	µg/l	0,056	0,059	0,057
acenaften	µg/l	0,087	0,089	0,102
fluoren	µg/l	0,044	0,043	0,051
fenanthren	µg/l	0,063	0,057	0,059
antracen	µg/l	0,007	0,005	0,006
fluoranthen	µg/l	0,072	0,048	0,056
pyren	µg/l	0,042	0,030	0,035
benzo(a)anthracen	µg/l	0,015	0,008	0,01
chrysen	µg/l	0,014	0,008	0,009
benzo(b)fluoranthen	µg/l	0,017	0,01	0,012
benzo(k)fluoranthen	µg/l	0,007	0,004	0,004
benzo(a)pyren	µg/l	0,014	0,007	0,009
benzo(g,h,i)perylen	µg/l	0,011	0,007	0,008
dibenzo(a,h)anthrace	µg/l	0,002	<0,002	<0,002
indeno(1,2,3,c,d)pyren	µg/l	0,013	0,007	0,01
Cu	µg/l	**101**	**26,2**	**30,8**

Detection of accident causes

Our investigation of possible sources of this accident has pointed on BorsodChem-MCHZ, a chemical plant located some 12 km upstream of the monitoring station.

The part of the company's broad portfolio is aniline production. A spill from this production was probably the cause of the detected accident. This conclusion raised from the information found in an undated document „Evolution of the BC-MCHZ process for the production of aniline“ written by *Pasek*. According to this author, a technology that uses copper catalyst tablets for nitrobenzene hydrogenation was launched in 2006 in this chemical works. *Pasek* states that the problem with the disintegration of the catalyst has been observed several times. Our conclusion is also supported by the detected increased values of chlorides and sulfates. Their source may be nitrobenzene, which contains a small amount of sulfur and chloride ions, probably originating from the refined benzene which is used for nitrobenzene production. According to *Pasek* the deposition of such substances on this catalyst has been reported.

Continuous monitoring experiences

The operation of both continuous biological monitoring devices has fully demonstrated their suitability for detecting dangerous changes in the biological quality of water. However, it should be noted that although the use of these devices in an early warning system improves detection effectivity and rapidity which finally improve the level of protection against accidental, criminal or terrorist pollution of flows, the process of implementation of continuous monitoring to the routine practice has not been initiated in the Czech Republic yet.

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Expert information system NAVAROSO

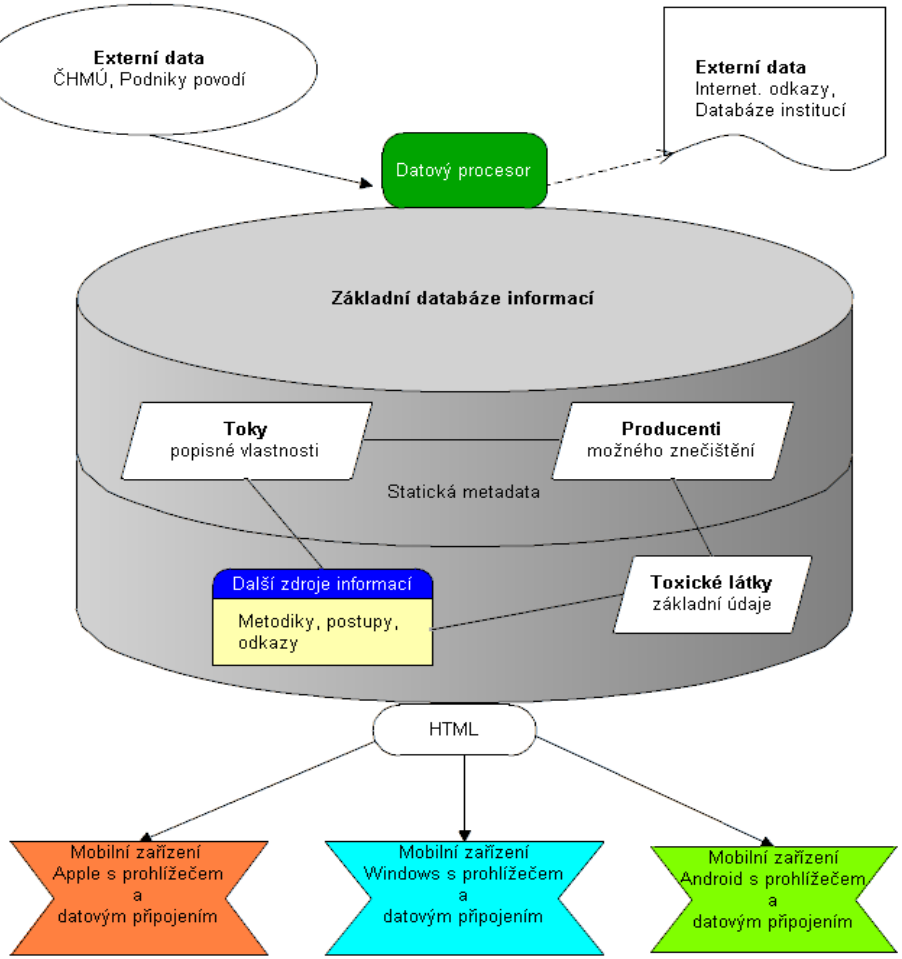
The project focuses on the development of specialized software - a information expert system for the integrated rescue system bodies, the Czech Environmental Inspectorate, water authorities and river basin administrators.

The construction of the NAVAROSO expert system respects the principles which were specified in the Methodology for the Declaration of Emergency Situations on Streams (mentioned above), which was certified by the Ministry of the Environment of the Czech Republic.

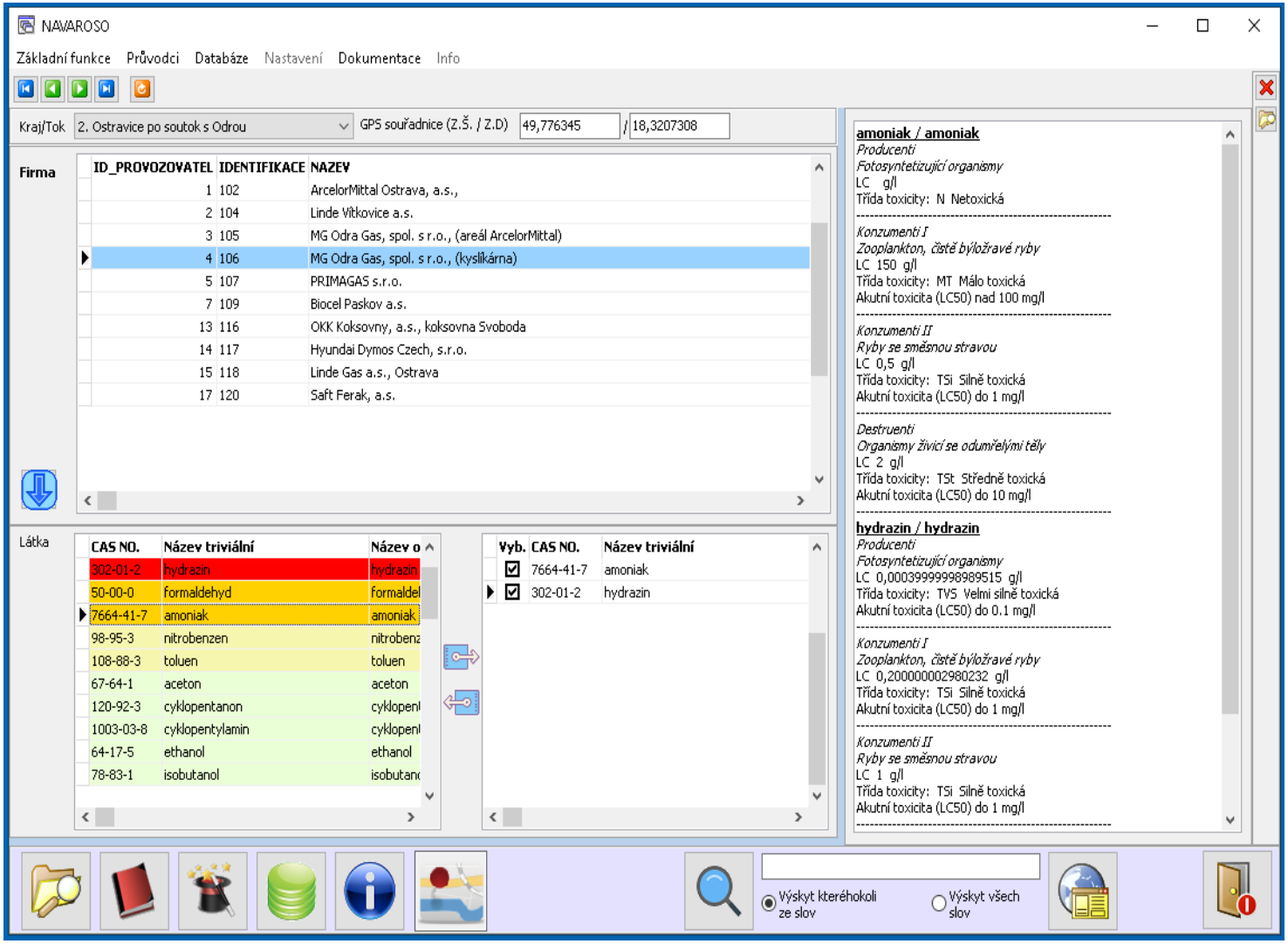
The system provides the cross-linked data necessary for quick information on the possible causes of deterioration in the biological quality of water, about procedures for determination of the type of pollution and estimating of its spread in the stream. The database system is supplemented by a module for estimation of the pollution behavior in the recipient. This newly developed expert system which will be available in the field on all types of Internet-connected devices enables:

- streamline the process of finding a source of water contamination quickly and demonstrably (this function is very important for preventing possible pollution)
- to speed up and refine the estimation of the level of contamination, thus enabling prediction of further development of the accident
- early warning of downstream sites and water consumers
- timely fulfillment of the Czech Republic's international reporting obligations
- provide more accurate information for the timely planning of an effective mitigation action

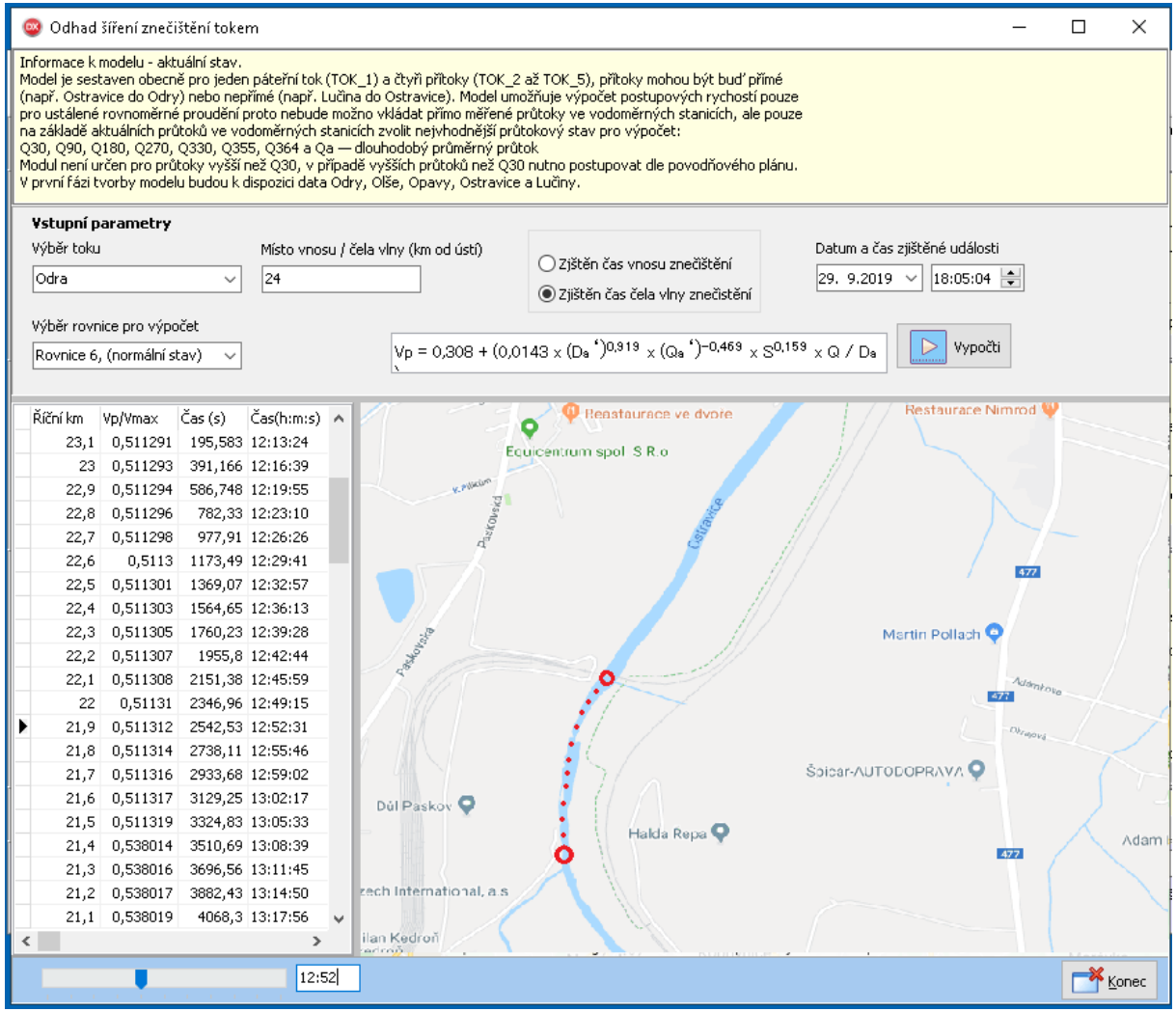
Basic data sources for expert system



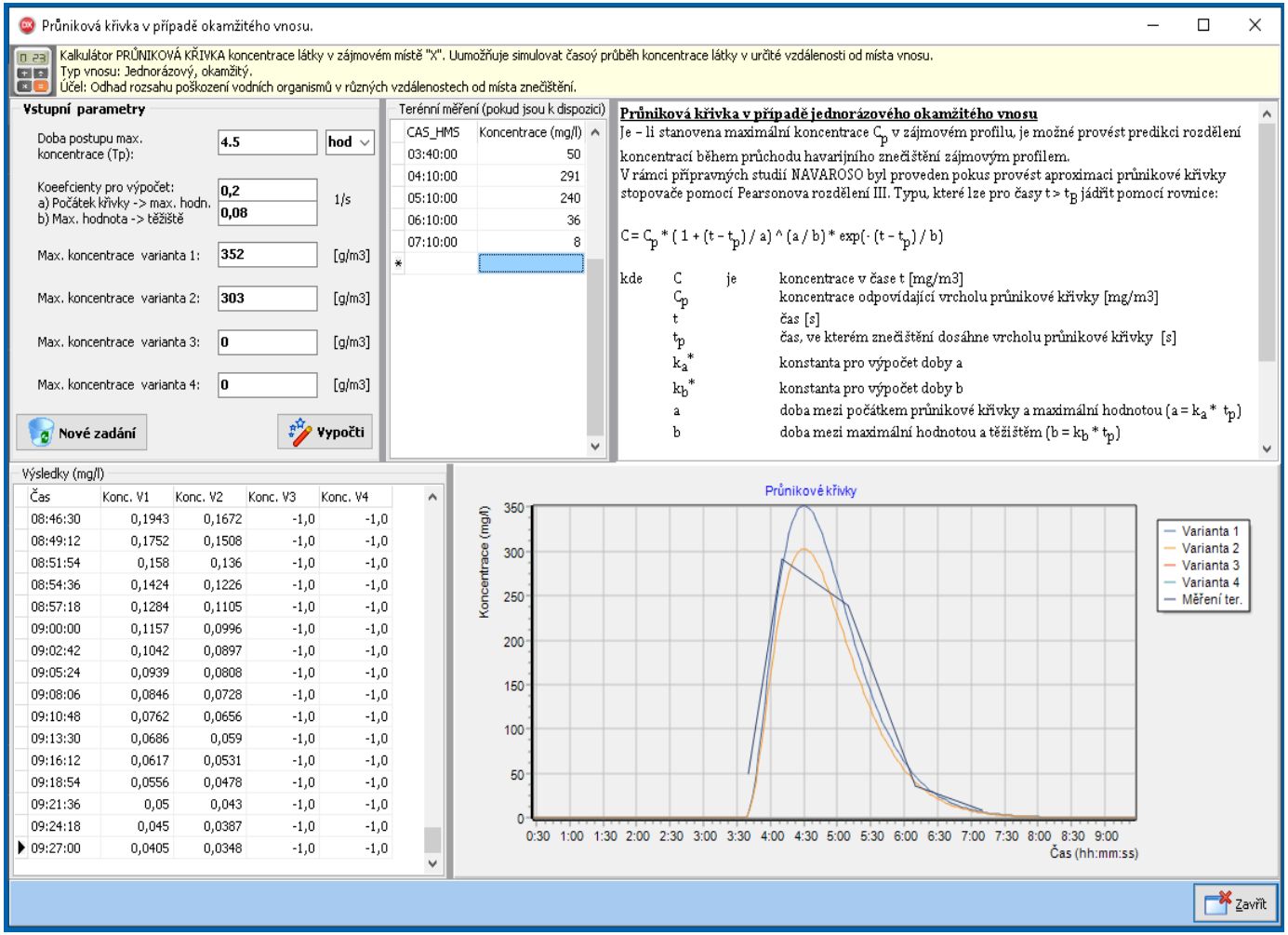
Printscreen of example of cross-search



Spreading of accidental pollution by flow



Printscreen of reverse analysis of contamination course



Key for detection of fish poisoning

KYANIDY

KYA

Obr. KY1: Jasně červené zbarvení žaber po otravě ryb kyanidy (foto: P. Beránková)
vlevo – žábry ryb po otravě kyanidy
vpravo – normální žábry

Obr. KY2: Ryby, uhynulé při havarijním úniku v Baia Mare (Rumunsko). Dobře patrný je výskyt subkutánních krvácenin (foto: neznámý autor)

DEFICIT KYSLÍKY

KYS

Obr. DK1: Při nedostatku kyslíku se ryby shromažďují u hladiny a kaprovité ryby dýchají nouzově, nepřijímají potravu, pohybují se pod hladinou, nouzově dýchají (kaprovité). V rybnících se ryby shromažďují u přítoku, jsou malátné, nereagují na podráždění, ztrácejí únikové reflexy a hynou. Nápadná je výrazně světlá barva kůže. Žábry jsou překrvené až cyanotické, žaberní lístky slepené, v přední oční komoře i v kůži skřelí jsou drobné krváceniny (foto: H. Kroupová)

Obr. DK2: Křečovitě rozevřená tlama a odchlípená víčka skřelového krytu a dravých druhů ryb jsou výrazným znakem úhynu v důsledku udušení (foto: H. Kroupová)

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Conclusions

We are convinced that the findings and outcomes of both presented projects can significantly improve and streamline the early warning system to manage emergencies of water quality changes caused by accidental pollution, terrorist or criminal activities.

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Acknowledgement

Presented findings and results were obtained within the projects NAVARO - Development of Early Warning and Response Tools in the Area of Surface Water Protection (project number TA01020714) and NAVAROSO Expert System (project number TH02030142), financed by the Technology Agency of the Czech Republic.